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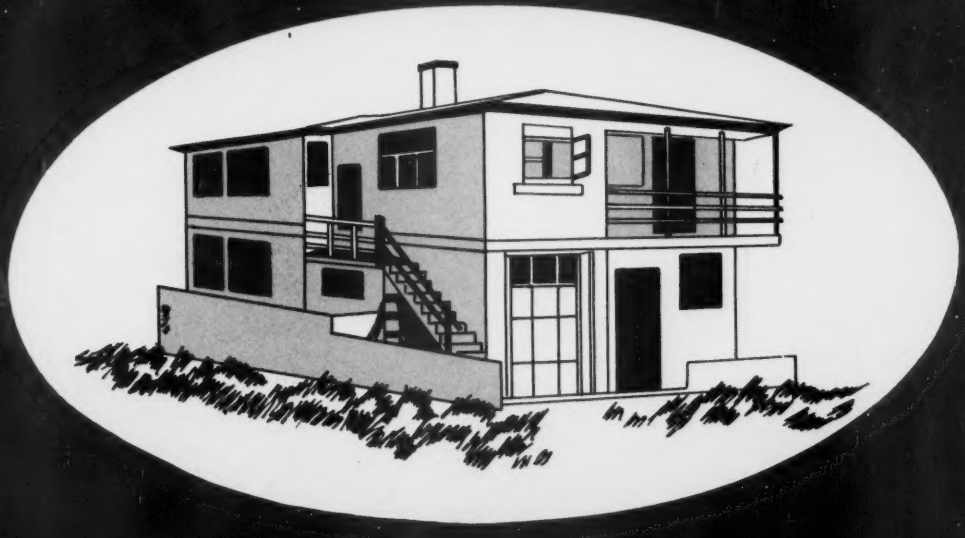

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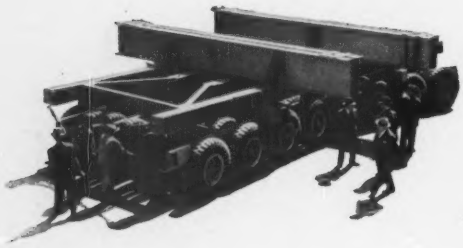

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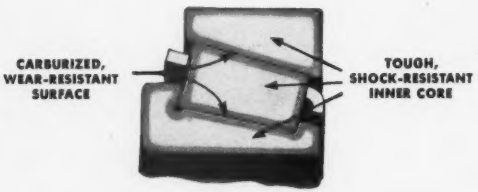

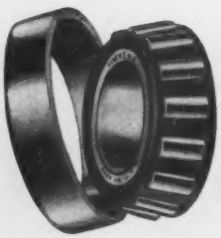

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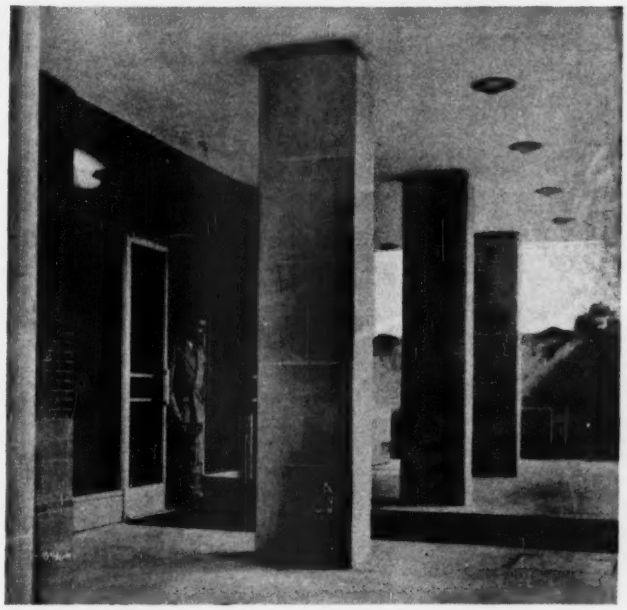

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from the earth's vaults

The Tale of Forgotten Wealth

By Charles Saltsman, '52

"By the deep six!" An echo of the rough, expectant voice glided across the ruffled water, lost itself in the heavy underbrush and crowded trees for a few moments, and then, in fragments, drifted cautiously back to whence it came.

"And a half five!" A solitary doe, nostrils twitching, looked up again. The great, white-winged creature came closer. The doe sprang round and darted off into the protection of the forest.

"Three fathoms" — a tinge of gruff excitement in the voice this time — "and a half."

Before the echo of this last call had found its way to the shore, the silent, slow vessel which had been edging its way into the inlet for many long minutes became an island of noisy, impatient excitement. A splash, followed by twenty feet of whining, slithering cable; a wild slatting of sails caught in a sudden, twisting gust of wind; a shrill scream of lines, whipping through blocks and sheaves; a sharp clamor of racing, climbing men. The ship swung about, her bowsprit pointing seaward again. Over the side of the vessel dropped a beaten longboat, accompanied by the shouts and curses of toiling men. As the smaller boat struck the water, a tiny circle of ripples danced out, heading off across the water toward the many bays and beaches of the world. They washed the shore of Plumb Point, but a few hundred yards from the ship, and then returned, headed for the sea, passing in their flight a heavily laden, groaning longboat, sweating its way toward the beach. They swept out past the anchored ship, and down the Pamlico River. The sun caught them, and they sparkled as they swept out into the wideness of Pamlico Sound. Here, joining larger waves, they spread out in a thousand different directions, washing ashore again at Bluff Point and Cedar Isle, and passing out finally, into the rolling plunging Atlantic through Ocracoke and Hatteras inlets. Here, at last unrestrained, they leapt northward, into New York Harbor and Hell Gate passage, soon to hold in its muddy bottom the hulks of the gold laden *Hussar* and the splintered *Lexington*. They dashed ashore at a dozen places on Long Island, already visited by Joe Bradish in his *Adventure*, bursting with gold and jewels, and soon to feel the tread of Charles Gibbs and the crew of his ship *Vineyard* as they sought a sanctuary for the silver-filled canvas sacks they carried. And still northward rolled the waves, to Oak Island, off Nova Scotia, where a treasure, even then ten centuries old, defies to this day the intrusion of fortune seekers.

The waves ran forth from the *Pamlico* in every direction. And in every direction they rolled above forgotten wrecks and lost cities, bubbled ashore on beaches filled with loot, lost themselves in brackish bays and dirty deltas, bursting with coins and jewels of other centuries.

The treasure trove of the earth is far more vast than many care to believe. Some estimates place the total

value of hidden wealth in North and South America alone in the neighborhood of three hundred billion dollars. Naturally, this is just the roughest of estimates, far from any kind of accuracy, but should it be but one-tenth of that amount, it seems to justify those who have spent their lives looking for it. And with its far longer, and more violent history, the treasure of the Old World must far surpass this figure.

But why has this vast amount of hidden wealth remained in the thousand hiding places for so long without discovery? Why, with our modern scientific methods, our excellent deep sea diving equipment, and our powerful machinery, capable of moving tons of earth each second, are we yet unable to locate the gold and silver put to rest with ancient spades, sunken in a few hundred feet of water, or stored in now jungle-covered cities of South and Central America, Africa, and Asia? The answers are many, and indicate that treasure hunting is not, after all, a simple task.

Take, for example, the vast loot that piracy accumulated and returned to the earth once more. The coves and inlets of Pamlico Sound are pocked with the buried treasure of Edward Thatch, better known as Blackbeard. Santa Rosa Bay, in Florida, holds still two of the caches of "Billy Bowlegs" Rogers, and this same gentleman's ship, with about a million dollars in gold and silver, should still lie in four fathoms of water in a small lagoon near Apalachicola, Florida, where it was

scuttled in 1840. Joe Bradish left a tidy sum in the vicinity of Montauk Point, on Long Island, and Charles Gibbs, better than fifty thousand dollars in gold at Southampton Beach, not far away. Jean Lafitte, besides sacks and chests of considerable value sprinkled here and there along the shores of Texas, Louisiana, and Florida, left a number of large cannon, their barrels crammed with gold, concealed in the swamps of Lavaca Bay, in Texas. The list is almost without end, and suggests that one has but to sink his shovel a few feet into the sand of any beach bordering the North American Continent to become a millionaire. But the treasures hidden along our coasts are either so well camouflaged that they have yet to be found, or they have already been located and quietly removed by those seeking to avoid the taxes that accompany the recovery of lost wealth. Or again, as has happened in many instances, nature may have aided the pirates and buccaneers in concealing their stolen goods by silently shifting tons of earth, destroying all landmarks and clues which might otherwise have led seekers to forgotten gold.

The vessel which visited the Pamlico River many decades ago might have belonged to any one of a number of gentlemen who sailed under the *Jolly Roger*, and it might have visited any one of the thousands of coves and inlets of this continent, for it is typical of the many visits paid to the secluded sections of our shoreline a century or two ago. Pamlico Sound itself is said to have been the favorite strongbox of many pirates. Of all that they secreted there, very little has ever been recovered. It still awaits the men who have the perseverance or luck to find it.

Many are inclined to envision the treasure-seeker as a luckless individual, covered with the dust and wrinkles of years of fruitless searching. Generally he is pictured as a whiskered beachcomber, quite drunk when he has the money, who will never be parted from the single doubloon he once found in the sand. Or he is a bleached old prospector, very near to dying of thirst, but pushing ever onward with the dim hope of one day finding the fabulously rich, but hopelessly lost "Bowie Mine." It is quite true that many treasure hunts end as failures, but it is also true that more than a few such ventures have resulted in rich finds. And the finders of most of the gold, silver, and jewels that have been recovered, have not, in general, been individuals or small groups, but rather, large, well-equipped expeditions or even governments of various nations.

In September, of the year 1780, the frigate *H.M.S. Hussar*, carrying more than four million dollars to be used for the pay of British troops in New England, set sail from New York. Hardly had she started when, trying to navigate Hell Gate Passage, she splintered her bottom on Pot Rock, in the East River, and sank to the muddy bottom. The British Government, fearing that the rebellious colonists might recover the *Hussar's* valuable cargo, made it known that the vessel carried nothing of value. England, however, lost the Revolution and some years later, realizing that there was no hope of ever recovering her colonies, divulged the true contents of the *Hussar*. Since then, numerous attempts to find the hulk of the ship have all resulted in failure. She still lies where she sank, covered, perhaps, by a few feet of mud. She is well worth a few more tries, for her exact position is all but positively known.

Another, and almost fantastically rich treasure is connected with the legend of "El hombre dorado," or the gilded man, and Lake Guatavita, in Colombia. The legend tells of the wife of one of the early chieftains of the Chibcha Indians of South America, who, after her affair with another man was discovered, threw herself into Lake Guatavita. Thereafter, for hundreds of years, the natives worshipped her spirit, and each year made fabulous offerings of gold and jewels to her. As part of the solemn ceremony, the chief of the tribe was anointed with oil and sprayed with gold dust, which he later washed off in the waters of the lake. With the arrival of the Europeans, there began a frantic search for the scene of these offerings, but for many years it could not be discovered. When the tiny lake where the offerings took place was finally found, there

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prof. charles h. blake speaks:

communism

Trofim D. Lysenko is a geneticist in Soviet Russia. As head of the Lenin Academy of Agricultural Sciences he presented his views on the tenets and goals of genetics as it should be studied in the Soviet Union at a meeting of the Academy in 1948. The reaction to his statements falls into two distinct and contrary camps.

On the one hand, the classical geneticists are in sharp disagreement with Lysenko. His views contradict the established principles of genetics as it has developed through the years, they say.

But the men in the Soviet who work in agriculture, agronomy, and genetics are enthusiastic about Lysenko.

The above title was chosen advisedly. Any discussion of genetics in Russia involves some realization of the nature of Russian "communism." The quotes are also intentional since, in the writer's opinion, the so-called communism of Russia has little or no present resemblance to the idealistic communism which long antedates Marx and Engels.

Let us look, then, briefly at some aspects of the present Russian system. In the first place, communism has many of the characteristics of a religion. It is to be accepted on faith and, like a number of young, aggressive and absolutist religions of the past, it cannot brook any opposition. Being young, it can be thought of as still in the stage of revelation. If its adherents are told to believe today the opposite of what they were told to believe yesterday, that can always be explained as improvement, as further revelation, and no one is supposed to ask any other warrant for the changes. Perhaps its most important tenet is that the state is supreme, and will remain so, contrary to Marx. Once the state becomes supreme, it is able to exert its influence upon all aspects of life and culture. It is at exactly this point that we see its impact upon genetical investigation. The preferred status of Michurin genetics rests on the approval by the Central Committee of the Communist Party of Lysenko's statement of that particular genetic theory. What is really meant here is that Lysenko's brand of genetics accords with the political and economic views of the party. Whether or not it is scientifically sound, in our sense, is not regarded as important. Doubtless the Russians would put this last statement the other way round and say that only that which accords with the Stalinist theory of communism can be scientifically sound.

The second point may be called isolationism. As developed in present-day Russia, it is partly a desire to keep the people from learning what goes on outside Russia, and partly, undeniably, a fear of foreigners. On the other hand, this leads to a glorification of everything Russian, one might say, good, bad, or indifferent. Hence Lysenko's particular development of a sort of genetics has great advantage as it stems, in the Russian view, from a Russian origin. The fact that Michurin's work was not very different from that of Burbank and of many practical breeders of the last two centuries or so is not important. After all, no one in Russia could safely point out the resemblances. Those of us on the outside see them.

Our third point is that of plan. It appears to be the Russian view that, not only is it possible to completely plan what the state, and hence the people subjected to it, will do at any time, but that, in fact, the Russian state is so planned. The consequence of this from the standpoint of scientists is that there is no room for statistical variations; nothing can be left to chance. Hence, Lysenko says that it is possible to decide what kind of plant one wishes and go toward that goal by a straight-line procedure. This, naturally, is the kind of theory which is most acceptable to the powers-that-be in Russia. It is not without interest that the Russians have had some difficulty over accepting quantum theory and statistical mechanics because, again, these leave something to chance. Further, the Russians seem to have also accepted Nietzche's idea of the superman. We hear a good deal about the "new Soviet man." Classical genetics lends no support to the notion that by taking thought one can add a cubit to one's stature, either intellectually or physically. This is not to say that the cubit may not be added but it will not be done by wishing for it.

The fourth point is the concept of struggle. This may seem rather far afield from genetics; certainly the idea of the classes fighting with one another is something which most of the world is trying to outgrow and the Russians still foster. But it does have a genetic connotation because it is at the root of the great Russian regard for Darwinism, with its concepts of the struggle for existence and the survival of the fittest. This is not to say that the Russian application of these phrases bears too much resemblance to Darwin's views; it is the phrases themselves which are important to the Russians and not the original meaning attached to them, a phenomenon now well known in connection with other words. We might put it that while Darwin regarded survival of the fittest as being largely the result of a chance conjunction of a fit organism and a fit environment, the Russians would rather say that, having decided that a particular organism, let us say the "New Soviet Man," is the fittest, then he is fated to survive. As to the struggle for existence, it is not peculiar to the Russians to view human contests or diplomatic negotiations as equivalent to the struggle for existence, but I content that this is not at all so. In nature, the struggle for existence but rarely occurs within a species; it occurs between individuals of one species and those of another, or between individual and environment. Having gone this far with Darwinism, the Russians are happy to accept Darwin's rather tentative views on heredity. The idea that all of the component cells of an organism contain hereditary particles which were capable, to some extent, of passing from one cell to another; hence if those particles could be altered in the cells of the body, then the result could be some alteration of the reproductive cells. Darwin did not know the extent of the insulation between the body and the reproductive cells. He was prepared to accept, in some degree, the concept of the inheritance of acquired characters for which modern science finds little or no evidence. This concept, of course, is fundamental to the Russian view. It means direct attack on the improvement of plants and animals by subjecting them to the environment to which one wishes them to be adapted.

The Russians, then, have committed themselves to a particular sort of genetic theory which we may call Lamarkian, the inheritance of acquired characters, and an experimental method which is essentially unpedi-

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prof. dirk j. struik speaks:

The debate on the foundations of genetics in the USSR centers around the ancient question of the inheritance of acquired characteristics in plants and animals. Under attack are primarily the following points, usually associated with the classical school of genetics, founded by Mendel, Weissmann and Morgan.

(1) The germ cells of an organism, which are the carriers of inheritance (chromosomes) are, separated and isolated from the body cells (soma).

(2) Changes in the germ cells (mutations) do occur, either spontaneously or through outside influences such as radiation, but they are undirected, unforeseeable. Mutations are thus essentially at random.

(3) Chromosomes are the only agents for transmitting hereditary properties.

(4) New characters cannot be permanently acquired by the action of the environment.

(5) New characters cannot be acquired by vegetative hybridization (a process which begins by grafting one plant upon another).

A sixth, most outstanding, point in the controversy is the relation of genetics to the practice of agricultural experimentation.

and genetics

According to Pravda, *Lysenko stated at the meeting, "The Central Committee of the Party has examined my report and approved it." Then, says* Pravda, *at this pronouncement, "With one impulse, all present arose to their feet and gave a stormy, prolonged ovation in honor of the Central Committee of the Party."*

So the position of Lysenko as a scientist has been severely criticized by some, and strongly supported by others on both sides of the political fence.

We have asked Professor Blake of the Biology Department and Professor Struick of the Mathematics Department to offer their opinions on the matter.

The conclusions of classical genetics are the result of more than half a century of assiduous research, of which the Mendel experiments with peas and those of Morgan with fruit flies have become best known. In the course of the years geneticists have found many difficulties in maintaining the classical pattern, but they have, as a rule, tried to account for them by hypotheses ad hoc, working towards a gradual modification of the theory. The Lysenko-Michurin school, on the contrary, has launched a frontal attack on these principles, maintaining (1) that chromosomes and soma are not irreducibly separated, (2) that mutations can be directed, (3) that *the whole organism* participates in the heredity, (4) that the action of the environment (soil, conditions of planting, operations on seeds, embryos, birds, that is, operations in the "plastic" period of an organism) may produce permanent changes, (5) that vegetative hybrids can be used for the creation of new species. Moreover, the Lysenko-Michurin geneticists stress, far more than the classical geneticist, the unity of academic work and agricultural practice. The science based on this unity is called agrobiology; it is something new since the evidence for biological theory has so far been not unfrequently obtained in a haphazard way from travellers, stock breeders or planters (witness Darwin).

Soviet biology, like Soviet mathematics, has its roots in the work of some very great but isolated scientists from the Tsarist period. We mention Sechenov, Timiriasev and Michurin. The last two lived partly under the Soviets, who gave them great recognition. Michurin, who died in 1935, received fame as the creator of more than three hundred new and valuable varieties of fruit and berry plants. He has been compared to Luther Burbank, though he was not only a plant grower, but a distinguished scientist as well, as can be gathered from his collected works, now also available in English.

Popular interest in problems of scientific agriculture increased with leaps and bounds with the Five Year Plans, beginning in 1928, under which collective farming was developed on a mass scale. Improvement of crops and livestock, as well as the extension of arable land over new regions, became the order of the day. The Soviet government invested large sums in biological research. The study of genetics was greatly encouraged, but the geneticists, often trained abroad, failed to a considerable extent to bridge the gap between their research and the demands of a rapidly expanding agronomy. The Soviet Union, which had inherited a country regularly plagued with famine, was in a hurry to improve food conditions. Scientific help came, but not primarily from the research institutes. Much more came from the scientists and other experts of the Michurin school. And this eventually had its theoretical repercussions.

In the course of his experiments in improving agriculture, Lysenko, stimulated by his success in transforming winter wheat into spring wheat, began seriously to question the tenets of classical heredity theory. He found that Michurin had always taken a critical position with respect to official genetics. Calling himself a pupil of Michurin, he began to head a movement away from classical genetics. His work, often belittled by the leading academicians, was crowned with great practical success; in the last fifteen years most of the great changes in Soviet agricultural technique have been connected with his name. Thousands of collective farmers, rural plant-growing experts and breeders were enlisted in this work, together with those trained geneticists who became convinced of the scientific value of the Michurin approach. Among these achievements are mentioned the planting of frost-resisting wheat for Arctic, and drought-resisting wheat for arid regions, the summer planting of potatoes in drought infested areas, new methods of cotton growing, steps towards the increase of yield in millet, the improvement of kok-sagyz (rubber) culture, and the growing of better and new varieties of fruits and berries.

It may be asked if it is fair to ascribe all these new techniques to the Michurin school. Many geneticists, while recognizing the great merits of the unorthodox approach, believed, and still believe, that classical genetics can account for them, perhaps with amendments of the type already freely introduced by non-Soviet scientists. Lysenko, though willing to recognize the value of this argument, insisted nevertheless that a new approach was imperative, and in particular attacked the theory of randomness of mutations. He adopted as slogan the Michurin word: "We cannot wait for nature's favors, our task is to wrest them from her." The Soviet authorities, who were investing large sums in genetical research, also asked for clarification of the

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homes of the future

Mass Production in the Housing Industry

By Rai Okamoto, G.

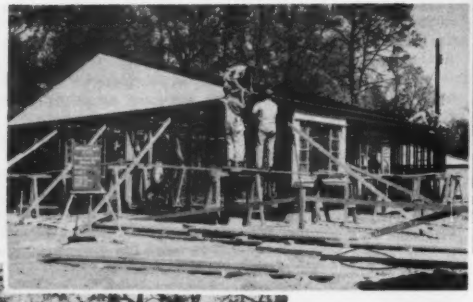
An apparently well-established ideal in America is the privately owned home perched upon a small plot of ground in the country. Polls and interviews confirm the universality of this concept. Whether it be a real or artificial wish is a matter for social psychologists to decide. What may be more important than this dream, however, is the clearly evident fact that despite our high standard of living and technological advances, too large a percentage of our portion of the world family is ill housed. No more densely packed or more widespread slum areas exist than in New York City and Chicago. Perhaps, then, it can be assumed that who owns the roof is of less importance than how well it functions as shelter.

One of the main factors underlying this shortage of adequate housing has to date not been successfully resolved. It is the failure of the essentially handicraft housing industry to adopt and integrate the rational techniques of mass production. This frustration is made more appalling in view of the great potentials involved. Mass production with its attendant lowered costs has made the automobile almost universally available. Yet we have so far failed to provide good housing, a more basic need, for more than a small percentage of our population. In its early stages the auto compared to the house in price. Today, however, the inefficient hand-made house still stumbles along at exorbitant prices. Many of the causes of the failure to industrialize housing were studied last fall as part of a project called "Housing — A National Securities Resource" in the Graduate class of Architecture at M. I. T.

The idea of prefabricating is itself old. As applied to housing we can see it today as a potential realization of the concept of "more and better things for more people at lower cost by means of the machine." The dream of the industrial age has never been realized in the housing industry. One of the reasons for this has been the shortsightedness of labor, business and political leaders. It has been reported that the output of labor was down thirty to fifty per cent from pre-war figures. Labor-saving devices such as power tools, spray guns, etc., an integral part of the industrial method, were suppressed. Special interest groups in business were exercising restrictive price-raising practices in the distribution of materials. Politicians aided by these groups were maintaining ancient specification codes favoring certain trades and materials. Performance codes were slow to appear. Such an attitude is death to the large industrial approach.

Inability of some young prefabrication companies to fully grasp the scope of their operations and to study thoroughly the marketing, financing and procurement problem has led to failure, thus delaying and prejudicing many against the arrival of industrialized housing.

It has often been contended that people are not psychologically ready for machine-made houses, despite low cost and efficiency. However, this will be at most a temporary difficulty if there is a real need, the price is right, and the product works well. Houses such as the famous Lustron all metal prefab brought many orders, but the story of that company's failure and of many others is familiar to all. It has been stated that these failures are a result of buyers' fears of standardization. This seems peculiar in such a style conscious society. No endorsement of fadism is intended. No one objects to the basic similarity of most of our automobiles. The failure of the housing business to really become an industry is, then, seen to be based on

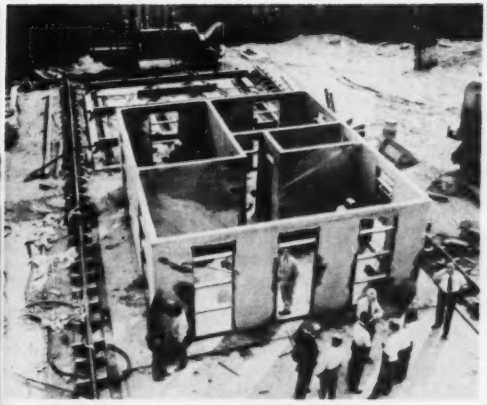


Lustron House

From left to right: The workmen shown erecting steel frame walls twenty-five minutes after the start of construction work. The concrete slab foundation had previously been poured.

After four hours, the steel frame walls are up, the roof structure is complete, and facing panels are being set.

The job is finished after eight hours of work. Only minor details, such as miscellaneous interior finishing, are left to be done.



IBEC House

At left we see the wall form being lowered onto the floor slab.

Above. Forms have been removed from the walls and transported to the next house site. The roof slab adjacent to the house is ready to be placed by a special vacuum lifting process.

a variety of factors, partly internal, partly external.

Setting aside temporarily the external obstacles and leaving them to programs of education and negotiation, let us examine more thoroughly the state of industrialized housing today. There appear to be two currently popular approaches to the matter. One is the prefabrication of the complete building in the factory, ready for delivery to the site. It may arrive folded or in erected form. It is characterized by an absolute minimum of site work and assembly. Variability is achieved by use of different models and capable site planning. If the concentration of similar buildings in an area is not too great and the landscape has any interest at all, much variation can be achieved through intelligent arrangement. It should be obvious that the type of placement which exists in the usual operative builder development, with its monotonous repetitive rigidity, only tends to emphasize similarity. Architects and planners consider original arrangement a more valid method of achieving the desired variability than superficial changes in material, color or decoration. Production of too many models, however, defeats the idea of mass production, thus leading to the second major approach. This calls for the fabrication of house components or building blocks. Using these basic parts, any number of variations are possible depending upon the ability of the architect. Usually the parts consist of wall panels which are integrally structure, insulation, outside and inside finish, and sound barriers, plus some sort of mechanical core. In the first approach mentioned the core is built into the building before shipment.

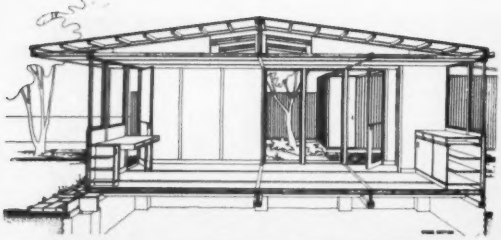
(*Continued on next page*)

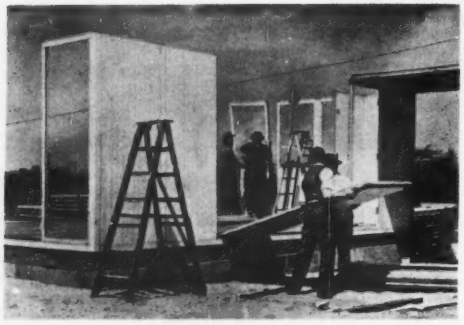
The form (above) on which the "Gunite" concrete will be sprayed is shown inflated.

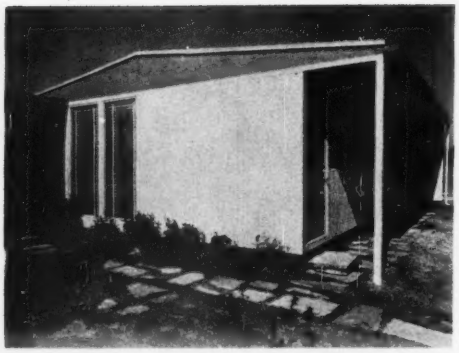
The workman (upper right) applying the first concrete coating. Insulation and a layer of waterproofing are then applied in a similar manner. After the concrete sets, the balloon form is deflated.

In the lower right hand corner we see a photo of the completed house, a graceful and unusual structure. These pictures were taken in 1941.

Airform or Neff House







General Panel House

Lower left. Erection of one of the General Panel Houses at Whitestone, showing the placing of panels in position.

Above left, cross section diagram, and right above' photo of completed house.

Core designs range from such extremely efficient units as the one proposed by Buckminster Fuller, which incorporates a water purification, recirculation and waste disposal device to one which consists merely of a compact grouping of existing units. In addition, research is now in progress which will eventually result in atomic energy plants for houses.

It is unfortunate that despite the presence of the first requirement, a need, neither of these purer forms of industrialized housing is succeeding. What is achieving some success is a sort of combination and adaptation of the two to field construction. Whole walls are prefabricated at the site and specialized workers move from house to house. The most well known exponent of this combination is the firm of Levitt & Sons, builders in the New York City area. This company maintains its own lumber mills, special equipment, supply stores, rental agency, etc., thus by-passing the usual blocs.

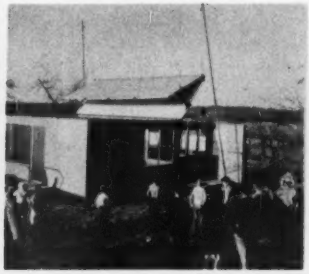
However, such success is not widespread. Probably the most publicized failure was the Lustron House. This was all steel with metal stud walls faced with enamelled metal panels. The Acorn House, designed by architect Carl Koch of the MIT Department of Architecture, has been ready for mass production for several years, but has never received the sustained number of orders needed to get into production. This house makes more efficient use of the material of which it is made, wood. The wood is plywood in the form of a stressed skin sandwich utilizing a core of phenolic resin impregnated paper. The panels are like the ones mentioned above, being structural and weather barriers at once. Like most of the other prefabricators, Acorn Houses, Inc. has been restricted by building codes. Despite the fact that tests by the Forest Products laboratory show these panels to be many times as strong as the conventional stud wall, the system is automatically barred by codes specifying four-inch walls regardless of structural performance. Such firms as National Homes and Gunnison Homes, who produce essentially conventional structures both esthetically and in structural principle, are slowly making sales. Frequently areas in foreign countries are good markets. The so-called Airform construction of architect Wallace Neff has achieved success in South America. This house makes use of the spraying quality of concrete in a process known as gunite. A dome-like form is inflated and covered with a wire mesh and the concrete is sprayed on. These have been used in Brazil, Argentina

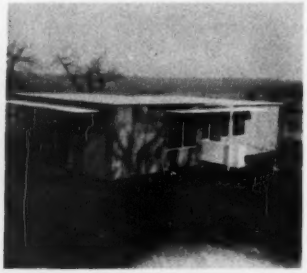
(*Continued on page 32*)

Below left, a trailer is shown carrying the complete house package.

Center. The roof panels are unfolded.

At right, we see the finished product.





summer cycling through europe

By John Peterson, '54

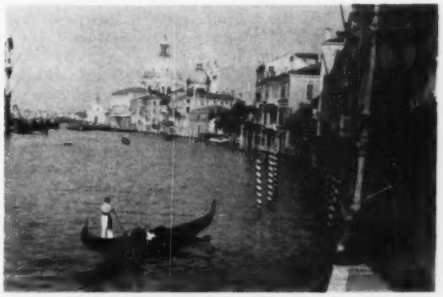
Travel in Europe is actually cheaper than in the United States. Once on the continent, one should be able to cover most of the countries very cheaply. The crossing will be the major expense, though.

Plane travel, even with out of season rates, is quite expensive. While it is much faster it is not very conceivable that a person on a limited budget would fly to Europe. A much cheaper way is that of taking a berth in the tourist class on one of the small trans-Atlantic liners. Round trip via one of these ships costs about $280 or $300. Not only is this comparatively inexpensive but it is also a very pleasant trip. Meeting people of foreign nations will be of prime importance during your tour and the ship should be the perfect place to begin. Reservations for such tickets should be made as much as a year ahead because of the great demand.

Once in Europe there are several ways of getting about. Of course there are trains and busses and even privately owned automobiles, but the cheapest and probably the most rewarding means is the bicycle. Even though your range on a cycle will be somewhat limited, the places you do visit can be much more easily observed. Pedalling over the countryside at your own pace, stopping for what interests you, is certainly better than flashing by in a car or train. Unless you want to visit a great many places in a short time, by all means try to cycle. It means going as far as fifty or sixty miles per day, but with some practice this is not really too hard. During a trip which I took last summer, I covered as much as seventy-six miles some days but it seemed that there was always someone at the hostels that night who had gone twice as far.

The best cycles for such travel are the lightweight English three-speed, hand brake ones. They cost less there. Unless you especially plan on doing more cycling at home it is practical to sell the bikes before returning. In most places the demand is very great for a used cycle.

The only way to travel on a cycle is to travel light. I took only one small handle-bar bag and a satchel strapped to the luggage carrier. This is really more than enough, though, if it is used correctly. You don't need more than one suit. By careful packing, it can be made to stay pressed for great lengths of time. Use as much nylon clothing as possible. It is easily washed at night and wearable the next morning, a great saving in weight. Of course you'll want a camera, but here again the small 35 mm. type will save much space and weight.



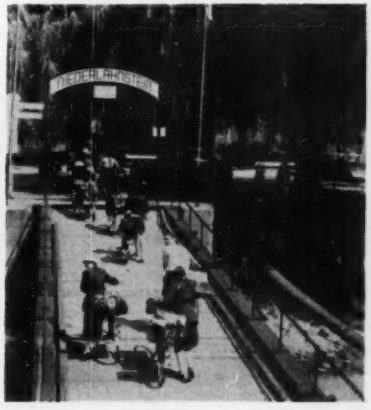
The Grand Canal, distinguishing feature of Venice, Italy.

Accommodations can also be arranged very cheaply. If possible, join the American Youth Hostels, Inc. Membership entitles you to the use of hostels all over the world. Cooperatively run, this organization provides cheap comfortable overnight accommodations wherever students travel. While they are certainly not luxurious, after a day on the road, cycling or walking, they are pretty nice places to eat and sleep. The cost is about fifty cents a night.

Most ships bound for England land at Southampton, an ideal jumping off point for a cycle tour of southern England. By making a slow loop first to the north-

(*Continued on page 26*)

Below, a typical English Youth Hostel, near Wells, England. At right, sightseers cycling along the Rhine River near Cologne, Germany.



a high fidelity audio system

By McKenny W. Egerton,'54

Altogether too much has already been said about audio systems which are both inexpensive and good. Probably few of them have lived up to the claims of their designers. The system to be described here was designed to meet the following standards, with cost a secondary consideration:

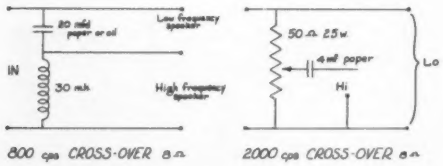


Fig. 1

1. Fidelity: The greatest possible illusion of presence.
2. Reliability: The set must last for years with little attention.
3. Adaptability: There must be means for handling unusual response curves, connecting external equipment such as tuners, recording lathes, and so forth, and provision for expansion.

An audio system consists of three major elements: a source (such as a tuner or record-player), an amplifier with appropriate response correction, and a loudspeaker system. It is generally agreed that the loudspeaker is usually the weak link in the chain, so we shall tackle this first.

No cone speaker yet designed has much usefulness above about 2000 cycles per second. (I see some raised eyebrows. Be thou not skeptical. Go and listen to a co-ax.) It has been customary to use a separate diaphragm type speaker for the treble. I would strongly recommend individual speakers rather than the concentrically mounted types. The high frequency speaker should consist of one, or preferably two, exponential horns. In any event it should have a reasonable dispersion characteristic. A unit with the lowest possible cross-over frequency is best, but the dispersion characteristic should receive the greatest attention. An 800 cycle horn that shoots a beam of piercing highs is not nearly as satisfactory as a well designed 2000 cycle unit which covers a fairly wide area. Good tweeters cost from $20 to $50, and their cross-over nets may either be bought or made up. One designed for 800 c.p.s. with an eight ohm output, and a rather makeshift, but useful, arrangement for a 2000 c.p.s. cross-over is shown in Figure 1.

The woofer, or low frequency speaker, might best also be an exponential horn. However, since a 40 c.p.s. horn is so large it would be necessary to place it on the side of a mountain, a substitute must be found. The Klipsch corner cabinet is perhaps the best compromise available today, and is quite effective. This may be built, but requires considerable carpentry skill.

Speakers may frequently be mounted in the ceiling, and this arrangement is extremely good if the ceiling is well insulated. A minimum of eight cubic feet behind the speaker is considered satisfactory. An attic is cause for celebration. Closet doors may be used similarly, and are highly satisfactory, but watch out for thin panels. A material sold under the trade name of Insulite is extremely useful for damping unwanted vibrations. Be prepared to ruin one or two keyhole saw blades if you try this setup.

For the driving elen ent itself, I would suggest four

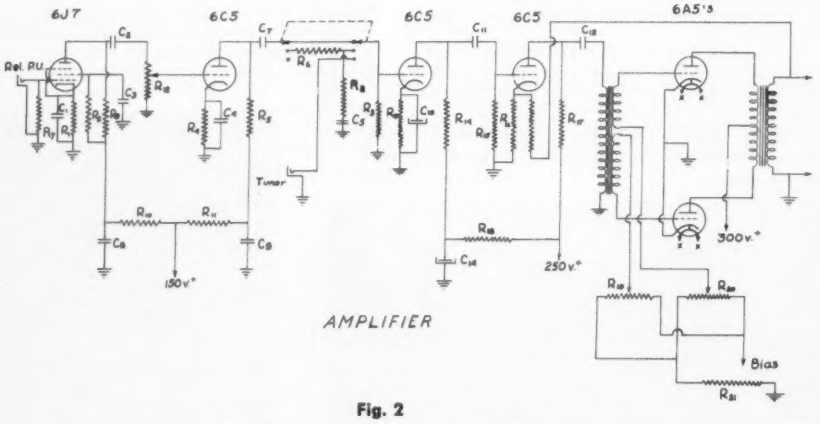


Fig. 2

C_1	50mf. 25 v.	C_8	25mf. 250v.	R_1	1200Ω 1w.	R_8	50k. 1w.	R_{11}	50k. 1w.	R_{15}	.5 meg.1w.	R_{19}	800Ω 2w. potentiometer
C_2	.1mf. 400v.	C_9	25mf. 250v.	R_2	590k. 1w.	R_7	15k. 1w.	R_{12}	.5 meg. volume control	R_{16}	2700Ω 1w.	R_{20}	800Ω 2w. potentiometer
C_3	20mf. 150v.	C_{10}	50mf. 25v.	R_3	.5 meg.1w.	R_8	12k. 1w. ±5%	R_{13}	18000Ω 1w.	R_{17}	20k. 1w.	R_{21}	16000Ω 10w.
C_4	50mf. 25v.	C_{11}	.1mf. 400v.	R_4	18000Ω 1w.	R_9	100k. 1w.	R_{14}	35k. 1w.	R_{18}	20k. 1w.		
C_5	.01mf. 40	C_{12}	.5mf. 400v.	R_5	47k. 1w.	R_{10}	80k. 1w.						
C_7	.1mf. 400v.	C_{14}	20mf. 350v.										

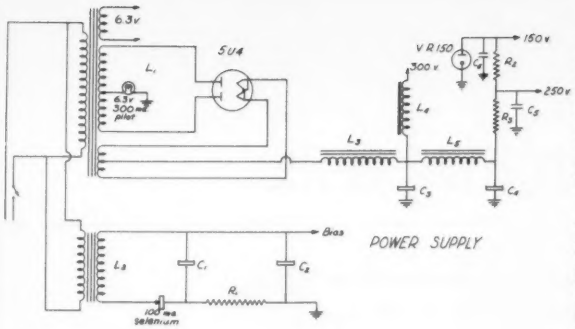


Fig. 3

R_1 700Ω 10w. wirewound
R_2 6k. 10w. wirewound
R_3 2@200Ω 10w. wirewound
C_1 20mf. 250v.
C_2 20mf. 250v.
C_3 10mf. 600v. oil-filled
C_4 10mf. 600v. oil-filled
C_5 40mf. 350v.
C_6 40mf. 250v.

L_1 Power x-former 400-0-400v.-150ma., 6.3v.-4a., 5v.-3a.
L_2 1@0v. 100ma. isolation x-former
L_3 20H.-150ma. choke
L_4 20H.-100ma. choke
L_5 40H.-50ma. choke

or more twelve inch units. They need not be especially fine speakers, but they should be reasonably good. Four $21.40 Jensen Concert Series speakers mounted this way will surpass practically anything else I have ever heard, and more or less expensive units may be used with corresponding results. A word of caution: Be sure they are phased. This can easily be tested with a number six dry cell, or even a flashlamp cell. When contact is made, all cones should move the same way. In overhead locations, the position of the tweeter offers some problems, but don't put it more than a couple of feet from the cone speakers, or a most unpleasant difference in direction and phase will be quite evident.

Whenever amplifiers are discussed today, two circuits are inevitably mentioned. One is the McIntosh, and the other is the Williamson. Both are excellent, but being a hide-bound reactionary, I still prefer a straight triode type. The rig I shall describe is almost pathetically simple and old-fashioned, but I have heard few better, and for reliability it is absolutely unbeatable. If I am not mistaken, I detect some skepticism on the part of the reader as he studies the transformer coupling, so suppose I devote a word or two to its merits. In the first place, a transformer will hold its balance, which no phase inverter yet invented will do. Also, it will not feed all its highs into one output tube, another common failing with inverters. It provides the necessary low resistance return for the grid without the usual monster coupling condensers with their attendant leakage and phase shift. And last but not least, with adjustable bias, it is quite feasible to run your amplifier into class AB_2 for short periods of high output without excessive distortion. It is important that the transformer be a good one since a cheap transformer is worse than the worst of phase inverters, and that is pretty bad. I would recommend U. T. C.'s (United Transformer Corp.) LS series for both input and output. They are neither the most expensive nor the cheapest available, and many others are suitable. Partridge transformers must be made to order in England but, due to the devaluation of the pound, are a little more expensive than the LS types, and a bit better. They are well worth investigating.

I have not suggested a value for the feedback resistor, since this will depend on the output tap and the transformers used. Somewhere around 20,000 ohms is about right. Make it as small as possible, but watch for these two indications of too much feedback: irregular response curves may develop due to phase shift. The most aggravated case of this would be the case of positive feedback. The other limiting factor is the gain. It may be possible to lower the gain of the output stage so far that the input stage overloads. The amplifier should be able to deliver about ten watts or better with negligible distortion from the driver.

The choke in the output transformer return is not absolutely essential, but it has beneficial effects, particularly when using a relatively inexpensive output. This is an old trick rarely found in modern amplifiers, but aside from a little extra hum filtering it does two useful things. First it virtually eliminates unbalance in the transformer, and to some extent in the output tubes. Secondly, it provides excellent degenerative coupling to the preceding stages.

Several measures are employed for the reduction of hum. A separate chassis is used for the power supply. If you insist on using a single chassis, put the input transformer as far from the power transformer as possible. Really obstinate cases of transformer coupling may sometimes be remedied by the following rather drastic means. Put the offending unit in a soft iron case with at least a half-inch clearance all around. Stuff the intervening space with annealed steel turnings, and pour full of pitch. Then mount the transformer on a wood or bakelite block about a quarter inch off the chassis.

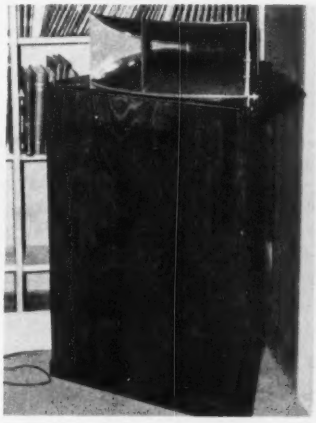
This amplifier, with no feedback line, is easily capable of 20–20,000 c.p.s. within ½ decibel, and will give considerably less trouble than the more complex modern circuits.

Good A.M. tuners may easily be built. T.r.f.'s (tuned radio frequency) are also suitable. The Miller crystal receiver is surprisingly good. F.M. tuners are probably best bought but the Heathkit unit is better than most. The limiter discriminator types are apt to be more satisfactory than the now popular ratio detector, due to the relatively small tendency of the former to drift.

Turntables are a source of debate. Unless you want to spend over a hundred dollars, rim drive turntables

(*Continued on page 26*)

The new M. I. T. library audio system, considered the ultimate in sound reproduction. At left is the Presto turntable equipped with Pickering tone arms. At right is the Klipsch corner cabinet.



tech engineering news

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from the editor's notebook

Each year brings a new crop of freshmen to M. I. T. It is always interesting to note the response of the new class to the situations it encounters at Tech.

In at least one respect it seems that every incoming group is identical to the previous one. Each member of the class is critical, to some extent, of the course of study which is thrown at him during his first year. Undoubtedly many of the criticisms are well founded. Among these I would include the complaint against the lack of time in which to really think about and absorb the concepts developed in each subject. Another valid objection is to the fact that M. I. T. furnishes the undergraduate with "teaching scientists" instead of "science teachers."

However, there is one criticism commonly voiced by freshmen which I think is definitely shortsighted. I often hear chemistry majors complain that the course in physics is useless to them. Similarly, physics majors are extremely unhappy about their course in chemistry. Budding mathematicians can see no use for either. All agree that they would be delighted to forget E11 and E12.

It can be easily shown that this viewpoint is fallacious. The physicist often needs some understanding of chemistry. The chemist will use his knowledge of math and physics to advantage many times. Although there has been a trend toward increased specialization in industry, this cannot be carried too far. A broad understanding of principles is a better base for further study than mere knowledge of detail. The freshman year should provide this basis.

About Our Authors . . .

Charlie Saltsman continually surprises us with the wide range of his interests. Here he writes about a most unusual topic. **Professor Blake** of the Biology Department and **Professor Struik** of the Math Department are well qualified to discuss the subject of genetics as they have both devoted much time to the study of recent developments in the field. **Kenny Egerton** is a member of the technical staff of WMIT. He describes an audio system which he built for his own home. **John Peterson** gives us the benefit of the knowledge he gained during his trip through Europe. If you intend ever to visit the Continent don't skip this article. **Rai Okamoto** is a grad student in Course IV.

A Faculty Member's Reply . . .

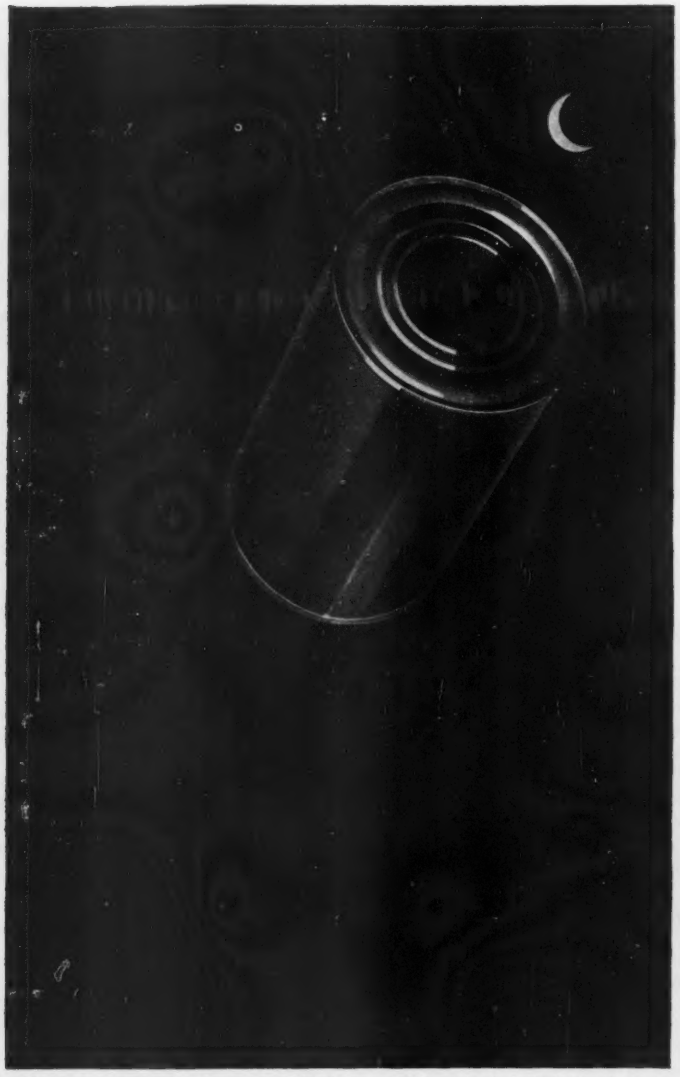
March 7, 1951

Dear Sir:

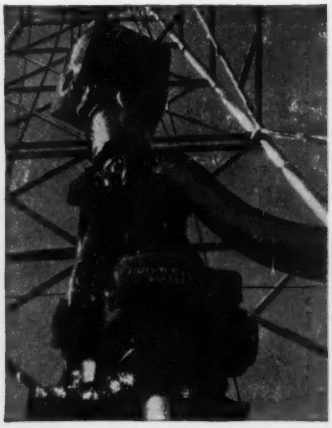
I think exception should be taken to the implication of the editorial on page 19 of the *T. E. N.* for February 1951. Whatever may be the case in the departments cited, it is certainly not the case in the Biology Department. Whether our curriculum is regarded as sound or otherwise it is, in any event, the doing of the Departmental Faculty. Having had something to do with curriculum changes in the department for about twenty-five years, I recall no case in which the initiative came from the students. On the other hand, I would not go so far as to say that students are always uninformed or unwise. It must be admitted that in some instances the students have been used as the thin edge of the wedge to break down the resistance of the other departments to admit our men to some courses.

CHARLES H. BLAKE
Associate Professor of Zoology

Only STEEL can do so many jobs



NINE TIMES THE DISTANCE TO THE MOON. Each year, it is estimated that America uses approximately 30 billion tin cans (in terms of an average-sized can) to protect food, oil, paint and hundreds of other products. Stack those 30 billion cans one on top of the other, and they'd stretch more than nine times the distance to the moon. A goodly percentage of these tin cans is made of U·S·S Tin Plate . . . steel with a very thin coating of tin.



MAN FROM MARS? No, it's an "Oilwell" Swivel and Rotary Hose . . . a common sight in the oil fields where they drill for the precious "black gold." Steel for oil-well drilling equipment like this is essential to building America's security. And U. S. Steel produces a great deal of it.

THESE PIPES CARRY COMFORT. You won't see them when the house is finished. They'll be buried in the plaster. But this National Steel Pipe for radiant heating will keep the rooms warm and uniformly comfortable, in the coldest weather.

AMERICAN BRIDGE COMPANY • AMERICAN STEEL & WIRE COMPANY and CYCLONE FENCE DIVISION • COLUMBIA STEEL COMPANY • CONSOLIDATED WESTERN STEEL
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so well...

THE MRS. McGREGOR'S FAMILY NAIL BOX—a wide assortment of small size nails—is handy to have around the house for any kind of repair job from fixing Junior's fire engine to mending Dad's stepladder. Wire nails of all types are today making an important contribution toward helping to build a better America.

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FACTS YOU SHOULD KNOW ABOUT STEEL

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1000 freight cars	2 cargo ships
2000 trucks	2 tankers
12,000 autos	500 tanks
3000 houses	800 airplanes
20,000 refrigerators	1000 anti-aircraft guns
20,000 stoves	1000 howitzers
1 aircraft carrier	2000 aerial bombs
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from the earth's vaults

(*Continued from page 7*)

followed a score of unsuccessful attempts to recover the wealth on its bottom. In 1900, a British company, deciding to end the search once and for all, drained the lake of its twenty-five feet of water, but found that the muddy bottom, into which the treasure had sunk, solidified when it was exposed to the air, and was so impenetrable that the company had to cease operations thirteen years after it had begun. It has been estimated that Guatavita holds in gold alone better than five billion dollars!

Not all of the many salvage companies have met with failure. Spanish, French, Italian, and American expeditions have recovered twenty million dollars from two of six treasure galleons that were scuttled in 1702 in Vigo Bay, Spain. These ships comprised the most valuable plate fleet that ever returned to Spain from the New World, but were destroyed when attacked by a British fleet under the command of Sir George Rooke. The treasure has not all been removed: there is still at least one hundred million waiting in seventy feet of water for those who care to tackle the job. The combined fleets of Egypt and Turkey, sunk in Navarino Bay off the coast of Greece by Greece's allies in her war of independence from Turkey some hundred and twenty-five years ago, contained nearly fifty million dollars in loot. Two hundred and fifty thousand of this has been reclaimed. The Greek government will be glad to grant sole recovery rights to anyone wishing to go after these millions.

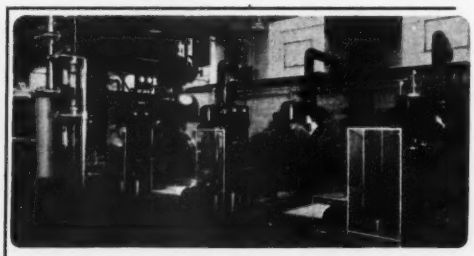
To exceptionally ambitious gold seekers, most of these valuable treasures are hardly worth the trouble. They are interested in the far more wealthy, and generally mystery-shrouded caches buried and lost in various parts of the earth's surface. Into this group fall the mysterious, and sometimes mythical lost cities, stories about which pop up from time to time. Some of them, as in the case of the sunken city of Port Royal, off Jamaica, in the British West Indies are definitely known to have existed. This famous city was built and thrived on the trade of piracy, and while it enjoys the reputation of having been the wickedest city on earth, it was also the richest. But on June 7, 1692, an earthquake drowned the entire city, with all of its gathered loot. While, on a clear day, the outline of its buildings can be seen, only a small portion of its wealth has been raised. And, not far away, on Nevis Island, the city of Jamestown met exactly the same fate in 1680. This city, the capital of the small island, differed from Port Royal in that it was known for its culture and learning. It was also a wealthy city, the home of many prosperous planters and legitimate merchants.

While both Port Royal and Jamestown have been located, and may actually be seen, there are others whose existence is based on records, early literature, and legends. The Dead City of Brass is one such. It is reported to have been a rich and flourishing city deep in the Sahara Desert many centuries ago. Its name is derived from two great towers of brass which are said to have predominated the city's great buildings. It is recorded that the end came with a drought of many years duration. Several expeditions have failed to find the city which may now be buried in the sand. China boasts at least two lost cities: Yotkan, a thousand years ago the rich capital of Sinkiang, and Khara-Khoto, a Mongolian metropolis which seems to have been abandoned when the two rivers that ran through the valley in which it was situated, dried up, causing a much traveled caravan trail to be re-routed. The former of these two may have given a clue to its whereabouts, when, some years ago, an irrigation canal which was cut for some distance through a cliff in the vicinity of the lost city, overflowed and spilled out a sizable amount of gold in small pieces. A wild gold rush caused the countryside near the scene of the overflow to be lowered several feet.

Undoubtedly the most mysterious of the lost and deserted cities is that of Ankor Wat in Cambodia, French Indo-China. This templed, jungle-covered, but still magnificent city is the subject of much controversy, even as to who once inhabited it. One theory suggests that it was a tribe who worshipped monkeys. Why the populace left is the subject of numerous wild guesses. But to treasure hunters, it is not the mysteries of the city which are amazing, but the vast hoard of gold and jewels hidden somewhere under the Bayon, or chief temple, and watched over by a great emerald Buddha. An ancient historian named Qon, wrote, during the twelfth century, that among the treasures were one hundred and twenty gold howdahs and three hundred gold chariots. Fantastic? A number of years ago two men found a sliding panel which led into the vault. Their sketchy accounts seem to affirm the legends about the treasure. They were driven from the vault by a large white cobra, and, returning, could not find the panel. Absurd? One of the two was rewarded by a fistful of pigeons' blood rubies which he snatched from a bowl in the vault. These stones constitute a small fortune by themselves.

So we see that there is almost unlimited wealth yet to be found. But there are great obstacles in the path of the treasure seeker.

(*Continued on page 22*)



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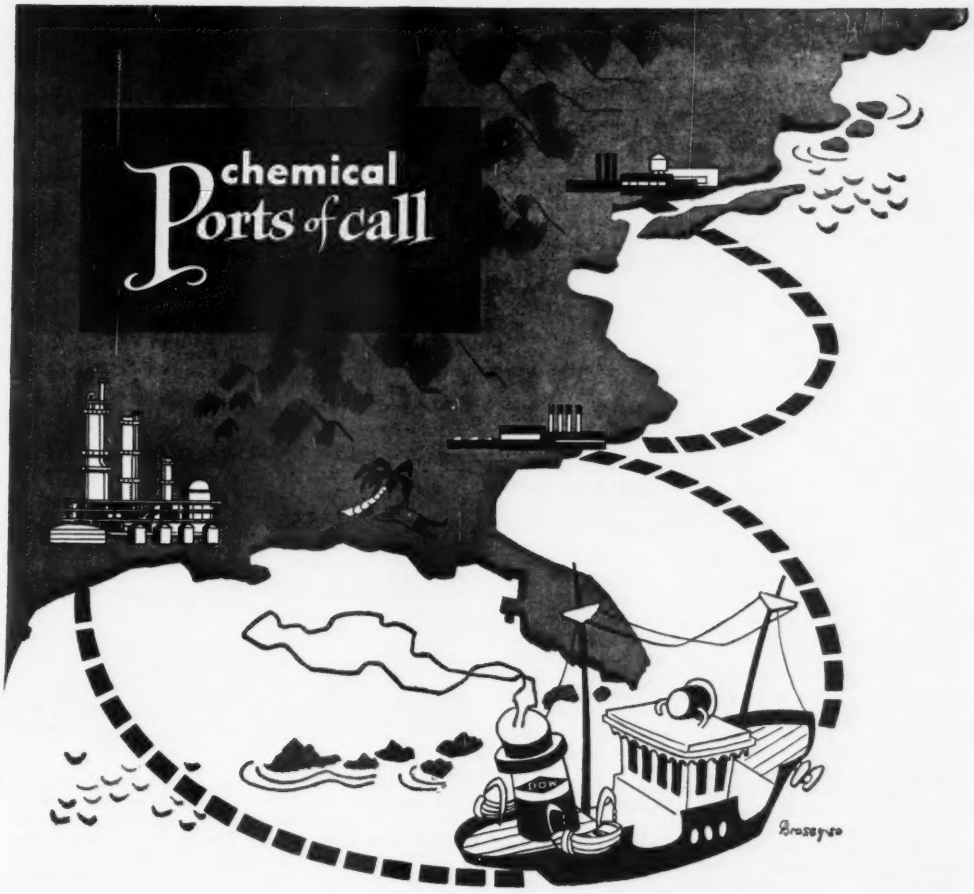

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CHEMICALS
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from the earth's vaults

(*Continued from page 20*)

The cost of treasure hunting is often great. Most of the failures in this "profession" have had their origin in lack of equipment, lack of capital, lack of information, use of the many spurious maps which are on the market, or a combination of all of these. And, having found a treasure, there are taxes and fees to be reckoned with, unless the "finds" are kept secret, as has been done in many cases. The United States requires the face value of any treasure found, and while this may be but a small part of the actual disposable value of the treasure, the remainder of the income is still classed as taxable income. Most countries are far less lenient. Some governments will sell treasure hunting licenses and rights. Costa Rica has inaugurated a neat system of taxing the thousands of hunters who pour over the famous Cocos Island each year. In addition to a sum to be paid directly to the government, all parties are required to take anywhere from four to a hundred soldiers along, paying them their wages. Thus treasure seekers are not only keeping Costa Rica out of debt, but are paying its army as well.

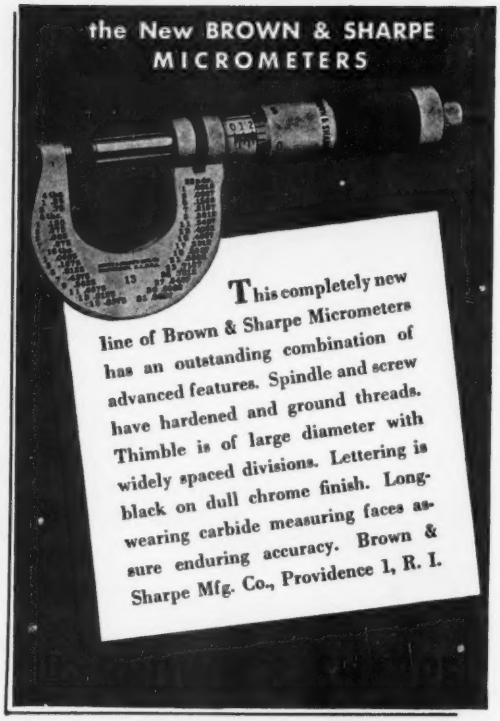
Modern scientific equipment should be of great help in locating a little gold. There are a couple of dozen lost mines scattered about our own Southwest as well as in other parts of the world that might be finally relocated with the aid of metal detecting devices; a good husky bulldozer run around the beaches of the Atlantic seaboard might turn up something interesting. But a word of caution if you should have caught the treasure fever. There are many fortunes which can be found easily as far as any actual labor or capital is concerned. But there are other factors which must be dealt with. Religious resentment toward grave diggers and bandits has more than once halted fortune hunters when the end was nearly in sight. And there is scarcely one among the many professionals who does not appreciate very real problems attributed to the realm of the supernatural.

In conclusion, we may mention two more particularly unusual examples of lost treasure. The first of these concerns the mysterious Oak Island, in Mahone Bay, Nova Scotia. The island gets its name from the fact that it is the farthest north that oak trees have been known to grow. But it is not the trees which have excited the imagination of thousands for a century and a half. It is rather the treasure which lies beneath its surface, so cleverly concealed that millions of dollars, years of labor, and tons of machinery have failed completely to obtain whatever has been secreted there. The current story begins in 1795, but the history of the treasure itself may extend back over a thousand years! The three young men who landed on the island a century and a half ago discovered marks on a large limb of a tree suggesting that ship's blocks or rope halters may have been secured there and used as a derrick. A slight depression in the ground encouraged these men to secure shovels and plow into the ground in search of the gold-filled chests they were sure were there. Ten feet down they struck a wooden platform. Sure that they were close to untold wealth, they tore up the planks — only to find more earth. Another ten feet and another platform. They covered thirty feet and three platforms before quitting. Subsequent operations have gone down one hundred and ten feet, finding wooden platforms at each ten-foot level, with the exception of two, which were of ship's putty, and charcoal. At ninety feet a thin, flat stone with undecipherable characters was found. Shortly after this discovery, the pit flooded with seawater and investigations have uncovered an inlet tunnel connected with drains from the Atlantic Ocean which have effectively kept the pit flooded and operations at a near standstill. All efforts to destroy the ingenious system have failed. Probing in the muddy ground shows the vault to be solid cement, about forty feet high, with its bottom one hundred and fifty feet below the surface of the ground. A treasure company working at Oak Island is now faced with a new problem. Because of constant flooding, the vault shifts in its muddy grave.

It is possible that this fantastic structure is of Norse origin. Theory has decided that an early Viking settlement, for one reason or another, decided to abandon its colonizing, and, realizing that whatever could not be taken would never be returned for, built the remarkable crypt for the everlasting security of the valuables it must contain. So far it has served its purpose well.

The last story demonstrates that all the treasures still to be found are not those which have been missing for hundreds of years. They are still being lost or misplaced. This one, though of a much different nature than any of those previously described, is nevertheless priceless, and it disappeared but six years ago. It is a violin named Emelie, the most famous and the most valuable of all those perfect pieces made by Stradivarius. It had been owned by one of the most famous maestros, Paganini. It had a long life, thrilling millions with its perfect tone. But when the war ended, it was removed from the State Opera House in Munich, most probably

(*Continued on page 26*)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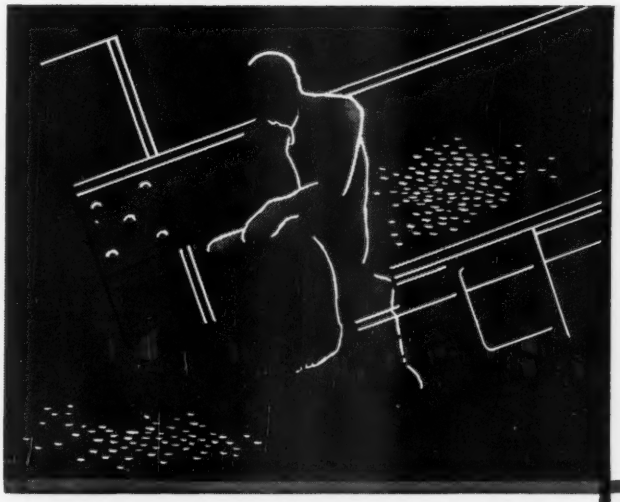
- ☐ Flutter Engineer
- ☐ Static Test Engineer
- ☐ Vibrations Engineer
- ☐ Weight Control Engineer
- ☐ Specifications Engineer
- ☐ Radar Engineer
- ☐ Structures Research Engineer
- ☐ Communications Engineer
- ☐ Dynamics Engineer
- ☐ Ultra-high Frequency Engineer
- ☐ Missile Test Engineer
- ☐ Electrical Systems Engineer
- ☐ Mechanical Systems Engineer



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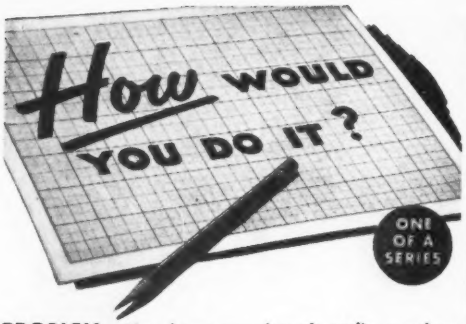

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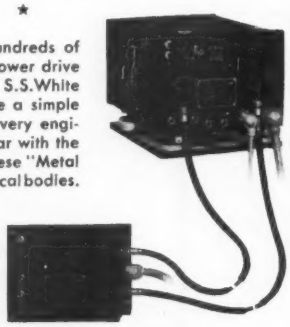

Here's how one large manufacturer provided an answer to this problem.

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summer cycling through europe

(*Continued from page 13*)

west, then east to London and from there south again to the coast, one can cover many of the more important tourist attractions of England. A few of these are the cathedrals of Winchester, Salisbury, Wells; Shakespeare's home at Stratford-on-Avon; and the colleges at Oxford. For the more modern minded there are many factories of various sorts to visit, and of course Windsor Castle should not be forgotten. In the great city of London one's time will be very well taken up visiting Buckingham Palace, Westminster Cathedral, the Parliament and many other famed landmarks like the Tower of London. This itinerary was the one I followed, and I feel that I covered England pretty well in my short stay.

Possibly the most interesting parts of France for cyclists are Normandy and the central area. Chateaus and quaint villages abound there and the terrain is not too difficult for uninitiated cyclists. Mont St. Michel, the famed island monastery, is in this region, as are also the chateaus of the famous Loire River valley.

Italy and Switzerland are difficult if not impossible to tour on bicycle because of the mountainous terrain. If you have not done much cycling be sure to allow for that in your planning. Not being able to cycle in these two countries tends to increase the costs of a visit there, but again you must make your own decision.

If you are interested in climbing, then plan to make an ascent in Switzerland. We climbed the Rifflehorn, near Zermott, and this will always be one of my most vivid memories. If you are interested in art or the ruins of bygone eras, then you should not miss Italy. Rome, Florence, Venice, Pompeii, and Milan are filled with such treasures.

Many of the traditional tourist attractions of

(*Continued on page 30*)

high fidelity audio system

(*Continued from page 15*)

are advisable. A very good center drive, however, is the ultimate. Whatever you buy, mount it solidly. I have heard a two hundred dollar table sound like a $2.98 G.I. (General Industries) due to the fact that it was mounted on ¼-inch plywood. Inch stock is about right. Put ribs underneath to damp vibration. Tables are frequently mounted on springs or rubber. Don't do this if you can possibly avoid it. The table will vibrate at a low, possibly sub-audible, frequency with disastrous overloading of the output stage.

The pickup arm is often a source of difficulty. The Livingston is probably the cheapest really good arm, but their straight models should be packed with cotton to avoid resonance. The Pickering is also a good bet. Clarkstan makes a $20 arm which has two advantages. One is an easily adjustable counterbalance. The other is the fact that it can be used with interchangeable pickups. It is really practical to use this arm both for L.P.'s and 78's. G.E. or Pickering pickups are probably best; let the price be the determining factor. You get what you pay for. The price for diamond styli is pretty staggering, but they are really the only satisfactory type. A sapphire is actually good for only fifteen L.P.'s before it develops pronounced flats.

Several sets have been built using these specifications and at present are performing quite satisfactorily. They are good audio systems. But, after all, the final criterion is whether you like what you hear.

THIS PICTURE STORY had whiskers when John A. Roebling built the Brooklyn Bridge, 85 years ago. • But the warning it sounds is as current and as urgent as it ever was in the history of our country. • No mule ever will get much of a meal by pursuing hay that is kept out of his reach by a stout pole. • No nation whose rising wage scale keeps prices spiraling upward ever will attain true prosperity. • No nation has yet found the secret of making products at prices that do not depend upon wages. • If we expect to stop the inflation spiral we're in, we will have to contribute more, individually, instead of merely collecting more, individually. • And let us not lose sight of this objective during periods of government controls that are temporarily forced upon us by national emergencies. Let us keep our eye on the long range picture. Let us remember that we can have more only if we give more...that we can not really increase our income, unless we also increase our productivity. • Inflation wages can no more catch up with inflation prices than our mule can catch up with that elusive hay. John A. Roebling's Sons Co., Trenton 2, New Jersey.

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ROEBLING

prof. struik

(*Continued from page 9*)

communism and genetics

prof. blake

(*Continued from page 8*)

issues. This resulted in large conferences, in which academicians as well as plant and livestock growers participated. The best known are the conference of 1939 with fifty-three speakers, and the conference of 1948 with fifty-seven speakers, representing a large variety of opinions. Both conferences received wide publicity; the 1948 meeting was reported in all details in "Pravda" and thus became known to millions of readers; the reports are available in English. Seldom, if ever, has a scientific conference taken place in an atmosphere of such wide public interest. The result of the 1948 debates was that the Soviet government decided that convincing proof was available of the superiority of the Michurin methods, both theoretically and from a practical point of view. Certain administrative changes were made in the research institutes, favoring the Michurin-Lysenko approach to genetics.

This active participation of the government is quite understandable if we relate it to its gigantic reclamation plans. The most ambitious of them is the great fifteen-year scheme of forest shelter belts, soil conservations, snow retention and irrigation for southeastern Russia over an area as large as western Europe, involving, among other works, the creation of forty thousand ponds and reservoirs. The support given to Lysenko can almost directly be estimated in terms of economic values, though in a country like the Soviet Union, where economic, political and philosophical questions are deeply interrelated, theoretical considerations have also played an important part in the discussions.

The outcome of the 1948 debate has been bitterly attacked outside of the Soviet Union. Much of this criticism only reveals that ignorance and malice with respect to the Soviet Union which is at present typical of a leading section of our public opinion makers. There have been hints of sinister melodrama in which Lysenko figures as a junior member of the Borgia family. Even respected scientists have stooped to bitter vituperation, which loses much of its poignancy if it is compared to the similar denunciation of Darwin by his contemporaries. Professor Agassiz in his days felt as bad about Darwin as Professor Muller is now feeling about Lysenko.

There are also factual objections against the new theory. They belong roughly to two groups, which, however, are mutually contradictory. According to one school of thought there are no improvements in Soviet agriculture, so that the claims of Lysenko are based on no evidence at all. The other school recognizes the great advancements that have been made, but asserts that they can all be accounted for on the basis of the classical chromosome theory, perhaps with suitable modifications. The first school contains those wishful thinkers who in 1917 gave the Soviets only a few months of existence, in 1920 laughed at the electrification plan, in 1928 called the Five Year Plan a humbug and in 1941 forecast the fall of Moscow within six weeks. They were wrong all the time.

To the second school belong the Russian opponents of Lysenko, and also many non-Soviet geneticists, including Professor Haldane. The Russians, with twenty years of experience to back them, have rejected this position, which does not mean that the paths of understanding will be permanently closed. The strongest arguments of the chromosome-geneticists are based on the enormous amount of research which bears out,

(*Continued on page 30*)

greed mass breeding. Having accepted this particular genetical theory it is evident that in a religious state, such as Russia, no room can be allowed for a competing theory. It is not necessary that the competing theory be scientifically incorrect in order to be banned. It need only be incorrect in a socio-economic sense.

As to Lysenko's evidence, we may summarize the analysis made five years ago by Hudson and Richeus. They list twelve lines of evidence which appear to have some sort of experimental basis. Five of these lines are equally in accord with Mendelian genetics. Three are contrary to well established evidence and Lysenko's requirement of unspecified conditions of the environment renders these lines improvable. Two other lines are somewhat intermediate between the first two groups with weak evidence or faulty assumptions. Finally the evidence from graft hybrids has not been, and should be, critically examined outside Russia. The question is whether, by grafting vegetative parts together, the effect on the fruit is more than on parts of maternal origin (such as pulp or flesh). Lysenko holds the reproductive cells to be also affected. It would not be very difficult to determine this question.

Finally, we must notice that the methods preferred by Lysenko in fact leave everything to chance. But if one never does any statistics on the results, one does not see that chance is the main actor. In this method of open or mixed pollination, there is no knowledge of the precise parentage of individual offsprings. The method has been very much used. It in some cases yields valuable results merely because it enables so many different parental combinations to be tried. We can hardly object if that is all the experimenter wants. It is a method which effectively prevented any development of Mendelian theory. Mendel's great methodic contribution was really to the technique of hybridization. One makes completely sure which are the parents of any given individual and keeps careful notes on the proportions of individuals of different kinds among the offspring of a pair of parents. Then one has some numerical data upon which to base conclusions. The variables are subjected to as much control as is possible. Admittedly we can not control all variables here, but we can at least control many of the significant ones.

One of the curious consequences of the Russian position is that we seem to find them at once materialist and vitalist. It is usually supposed that the materialist is by the same token a mechanist. But the Russians seem to reject a mechanist's explanation of heredity in favor of a vitalistic one. At the same time they are clearly materialists rather than idealists. I suppose that for them, in this case, a mechanistic explanation is also an objective one and they reject objectivity along with idealism. Politics makes strange bedfellows.

The essential conclusion to be drawn is not whether Lysenko is right or wrong, even though in this country we would say he is wrong in the matter of theory even though many of his observations seem to be in the literal sense correct, that is to say he has not made false statements about his observations. Rather we have to recognize that we are dealing here with a situation in which the social and economic views of a supreme government determine what one may think in fields far removed from their economic and human relationships. Ultimately we must ask the question: Is this the way to make progress? It would seem, if we may judge by

(*Continued on page 30*)

One-ton window for a supersonic wind tunnel

Just exactly how does a jet plane behave when it is roaring through the air at supersonic speed?

Scientists, peering through windows of Corning optical glass such as the one you see here, will soon have a more thorough answer to this question than ever before.

This piece of optical glass, weighing more than a ton, is one of two of the largest pieces of optical glass ever made. They will be used in the six by six-foot supersonic wind tunnel of the Ames Aeronautical Laboratory of The National Advisory Committee for Aeronautics at Moffett Field, California.

This tunnel generates wind velocities up to twice the speed of sound, equivalent to 1500 miles per hour at sea level.

The windows are six inches thick and 52 inches in diameter. They are so clear and free of imperfections that photographs of shock-wave and air-flow patterns can be made through them—to furnish scientific data of great value in the design of future airplanes and missiles for supersonic flight.

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CORNING
means research in glass

prof. struik

(*Continued from page 28*)

communism and genetics

prof. blake

(*Continued from page 28*)

or seems to bear out, their point of view. The strongest argument of the Michurinists is their unity of theory and practice: in no country on earth has experimenting been possible on such an enormous scale as in the Soviet Union. They point out that Soviet agriculture has constantly expanded, encouraging new methods and new crops, while capitalist agriculture has had and has to cope with shrinking economy and even destruction of crops; a situation which discourages bold scientific adventuring in agronomy.

Two other objections have been raised against the 1948 decisions; again they are mutually contradictory. One is that the Soviet government, in its hurry for direct results, has taken a utilitarian position and thus discouraged fundamental research. The other objection is that it has taken a doctrinaire position, sacrificing useful scientific work to sterile dogmatism. The Soviets answer that instead of killing the goose that lays the golden eggs, they have at last made the decision to fatten her. As to the accusation of dogmatism, every judgment of this point must take into consideration that the philosophical justification of the Michurin position was reached after many years of experimental research with results convincing to the extremely matter-of-fact Soviet authorities. As to the personal position of the Lysenko geneticists, there is no doubt that the general principles of Marxist philosophy have guided them in the direction of their work. The Michurin principle that man can direct nature is also one of the main tenets of dialectical materialism. Marxists have always supported materialist trends in biology; this interest dates back to Marx himself who was one of the first to recognize the importance of Darwin's work, appreciating it as supporting his own theories. Marxists consider philosophy not primarily as an academic subject, but as a guide to action.

Many persons have been seriously disturbed by what seems to them a serious offense against academic freedom committed by the Soviet authorities. This action raises the question whether the central administration of scientific research has the right to interfere with the direction of the research which is going on. Interference is admittedly dangerous, though circumstances can arise where such interference may be justified. The changes in the genetics personnel of the Soviet Union have only been of an administrative nature; several, if not all, the censored scientists still occupy leading positions in Soviet academic and public life. The physiologist Orbeli, who was the head of several institutions, had to yield one of these positions. He remains the head of the Pavlov Institute. Dubinin, whose institute was abolished because of its supposed sterility, remains an academician and works on the great reforestation plans.[1] The only man who lost his teaching position as a result of the controversy was the instructor at the University of Oregon who had written that we should read Lysenko before we condemn him. It seems fair to say that the administrative changes in the Soviet Union will have the tendency, not to destroy genetic research, but to concentrate on the influence of the whole organism and its environment on heredity, rather than on the behavior of the chromosomes alone.

Perhaps the gravest difficulty that the Lysenko theory has to cope with is its lack of a solid theoretical foundation. Taking the whole organism as its object of study its field is inevitably much wider than that of the chromosome theory, which subjects itself so neatly to statistical work. This is not necessarily a condemnation of the new genetics, since startling new scientific approaches have often been attacked on similar grounds. The Copernican theory, to take a most famous example, conflicted with the main tenets of the Aristotelian physics of its day, and was a re-evaluation of known material primarily on philosophical grounds. Darwin's theory seemed weak in many eyes because of insufficient paleontological evidence. Haldane has pointed out that classical genetics has already so far advanced beyond Weissmann's point of view that its growth can only be stimulated by a sound appraisal of the results of the Soviet geneticists. The Michurinists, however, clearly think in terms of a new approach, in the same harmony with the trends of socialist society as was Cartesian and Galilean science with the trends of the new capitalist society of the 1600's.

Much of the work of the Soviet geneticists is still poorly known in this country, and this helps the fostering of prejudice. It would be helpful if scientists of the Lysenko school would be invited to lecture in this country on their work; it would be equally helpful if geneticists, familiar with our ways of work and our terminology, would be able to spend some years in the Soviet Union and report on their experiences. This is only possible in an atmosphere of confidence and good will. Every effort to ease the international tension can therefore also be effective in clarifying the situation in the biological sciences.

[1] Related by Professor A. I. Oparin of Moscow at the World Peace Congress in New York and by Professor J. D. Bernal after a visit to the USSR, see *Soviet Russia Today*, August 1949 and October 1950.

Literature

The situation in the biological science. Proceedings of the Lenin Academy of Agricultural Sciences of the U.S.S.R. Verbatim Report, Moscow, 1948, 631pp.

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J. B. S. Haldane. In defense of genetics. The Modern Quarterly 4 (1949), pp. 194–202.

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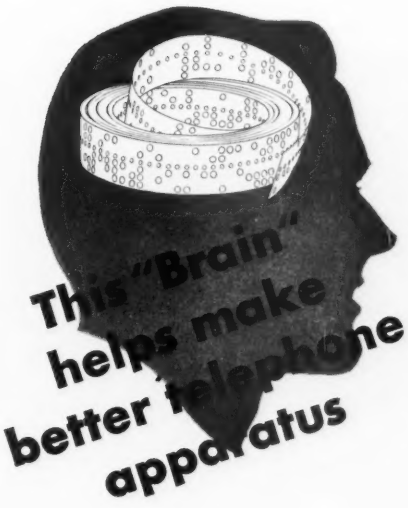
summer cycling through europe

(*Continued from page 26*)

Germany are destroyed now, but there is still much to see while cycling. The small German towns are very quaint and friendly. The larger towns have suffered more from the war, though, and it is not so easy for them to forget. We met the people who once were

(*Continued on page 36*)

Newsworthy Notes for Engineers

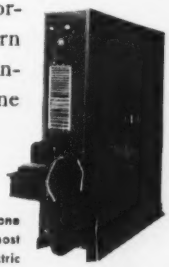


To improve the accuracy of testing Bell telephone switching equipment and to speed up tests during manufacture, Western Electric engineers designed and built a unique test set—known as the Tape-O-Matic—which has a paper tape "brain."

Controlled by a narrow paper tape, punched with coded information, the machine *automatically* performs complicated series of tests. If there is a fault in the equipment under test, the Tape-O-Matic stops, rings a bell and indicates the source of trouble on a lighted panel.

Some 1200 different tapes, varying in length from one to thirty feet, are used for testing various assemblies. Formerly an operator, in testing an average size assembly, had to make 41 individual connections. With the Tape-O-Matic, one multiple plug connection does the job. And 28 preliminary tests, 81 lamp observations and 71 key operations are replaced by one tape insertion and the push of a button.

The Tape-O-Matic can cut testing time as much as 80%—practically eliminates the possibility of human error—and helps to assure equipment of highest quality. It is a good example of the ingenuity, skill and thoroughness which Western Electric engineers put into making Bell telephone equipment.



The 1500-pound Tape-O-Matic is one of the largest, most complex and most versatile test sets that Western Electric engineers have ever devised.

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Engineering problems are many and varied at Western Electric, where manufacturing telephone equipment for the Bell System is the primary job. Engineers of many kinds—electrical, mechanical, industrial, chemical, metallurgical—are constantly working to devise and improve machines and processes for production of highest quality communications equipment.

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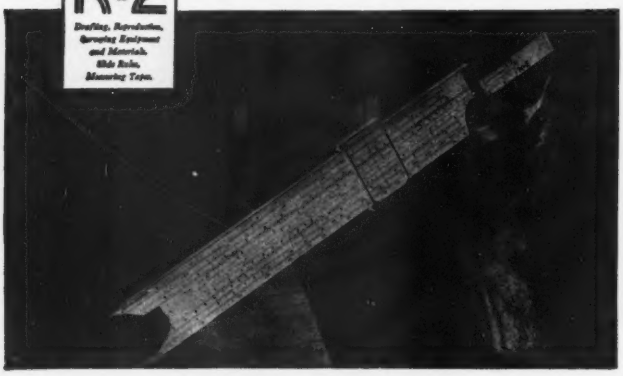

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homes of the future

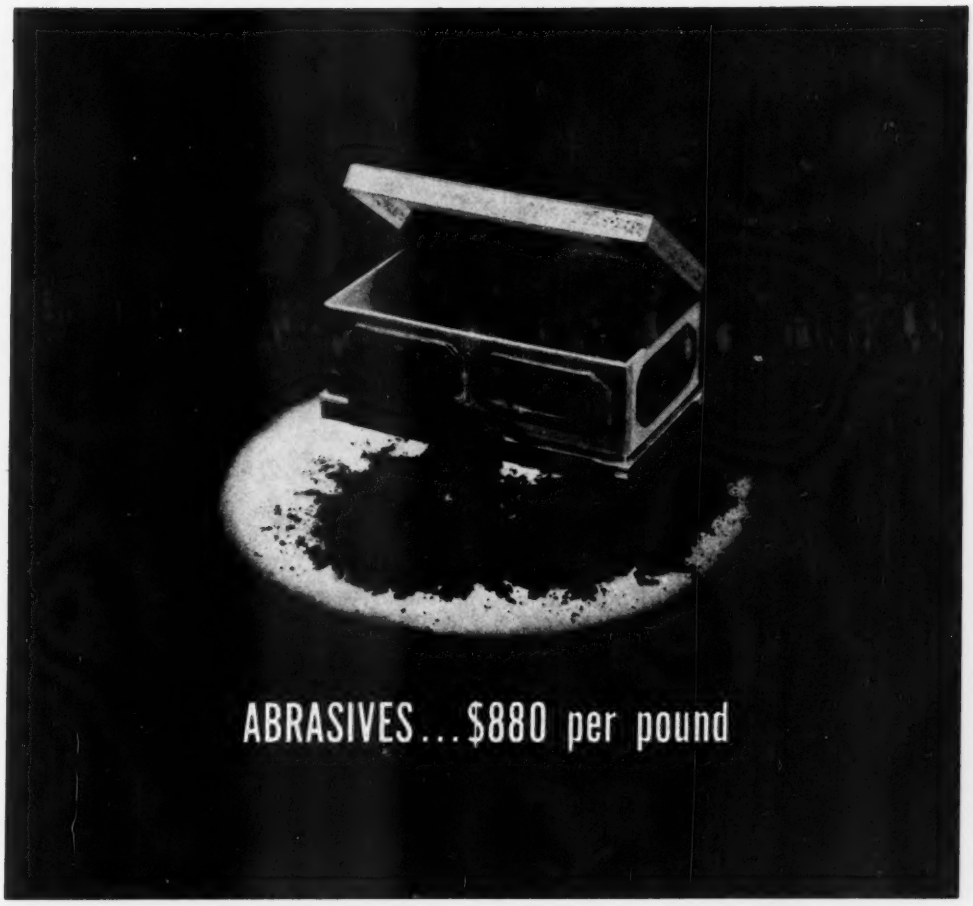
(*Continued from page 12*)

and other Latin American countries. Another concrete system to find little use here but acceptance abroad is Rockefeller Foundation sponsored IBEC house. Gigantic forms are used and the entire wall system of the house is poured at once. The forms of metal can be used repeatedly and result in great economy. The roof slab is poured independently and is lifted into place by a vacuum padded lift. Most flexible of the systems produced to date is the General Panel Corporation's panelized house. Based on a stressed skin plywood panel and a universal joint which permits vertical and horizontal connections, great varieties of plans are easily attainable. Although still in existence this company at last reports had sunk into comparative oblivion.

The latest work of Buckminster Fuller is conceded to have the best chance for success. Some critics of prefabrication systems to date have suggested that the failures may be due to a basically wrong approach. Too many of them are merely conventional systems broken into parts. These critics advocate a complete break with the traditional house form and the derivation of a new form from the new materials and new structural systems. Fuller has used this approach in his latest dome-like structures. The domes are constructed of metal tubes in tension following great circle patterns determined by the mathematics of energetic geometry which Mr. Fuller has developed. One of these domes is under construction in North Carolina and another is being completed by the Aluminum Company of Canada. Such structures are able to withstand the winds created by atomic blasts and are highly efficient enclosers of space per pound of material used. The domes could be covered with plastics of a weather resistant, transparent, type. Judging from models made by architecture students at MIT these structures have a unique graceful beauty. Yet with all its potential the Fuller dome has not yet achieved any significant gain in popularity.

Despite the many advantages offered by prefabricated houses, we cannot overlook the fact that many prefabricators were in too great a rush to grasp some of postwar housing money and sent unstudied products into the field. Poor engineering was the fault of many. The 1949 Lustron model was burdened with many different parts requiring specially trained workers. The plans of many were geared to the minimum standard which is becoming *the* standard. Most of the solutions did not take advantage of the inherent structural characteristics of the materials used, but tried to follow traditional forms. This resulted in unnecessary complexities. The engineering approaches in most cases were timid and did not recognize the product as a new concept of house. The function had not changed but the enclosing envelope was different, and ought to have been treated so. The analogy between the automobile

(*Continued on page 34*)



Even at hyper-inflated prices, it would be difficult to imagine any manufactured abrasive finding a market at $880 per pound. Yet this price was paid willingly in the first commercial purchase of silicon carbide familiarly known by the trade name CARBORUNDUM. At this seemingly fantastic figure jewelers, who previously used diamond dust, were able to reduce their abrasive costs by as much as 50%.

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the case of the annoying microinch

A. A. Michelson attended a dinner in his honor at the turn of the century, soon after he had won the Nobel Prize for Physics. On the table before him reposed a handsome wooden box. It contained a mundane bit of material with some lines closely ruled on it, called a diffraction grating. Mundane, but Michelson had labored for several years to produce it. Proudly, and with a dramatic flourish, Professor Michelson arose to display his grating to the group. Incredulously they saw it slip from the box and break into smithereens on the floor, forever lost.

Such an incident is typical of the history of "ruling" gratings — an art which is at once crucially important to experimental physics, and exasperating and discouraging to those near-heroes engaged in it. For though a diffraction grating is only a metallic surface ruled with thousands of closely spaced lines, the accuracy required in the ruling of the lines has proved an almost insurmountable obstacle.

What is known of the structure of the atom is largely from photographs of the spectra of the elements. And spectra are commonly produced in the laboratory with a grating, which by virtue of its particular optical properties reflects light of differing wavelength in different directions.

A good grating is known by its high resolving power, which is defined to be the wavelength of a spectral line divided by the wavelength difference between it and that of a neighboring line which can just be distinguished from it on a photograph of the spectrum made with the grating. Michelson was the most successful of grating rulers, for he made two gratings for which he claimed resolving powers of 600,000 — to be contrasted with the average of about 200,000. Unfortunately, one of these was the one described above, and the other had been ruled on a plate that was too thin, and so warped and became useless.

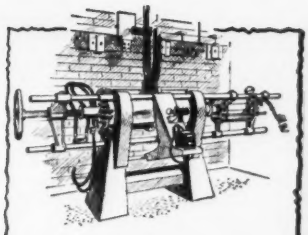
(*Continued on page 36*)

homes of the future

(*Continued from page 32*)

and the prefabricated house was overworked. Government subsidy of the auto industry through establishment of roads was overlooked in hastily following automobile techniques. The house is worthless without its land, so a land purchasing problem arose. However, before solving the complex external problems the internal ones must be eliminated. There is much room for the simple well engineered structure.

Certain characteristics of the industrialized house seem destined to prevent a loss of interest in it, despite the dark picture set forth. Modern warfare or the threat of it is changing our society to a potentially mobile one. Besides the preparation for emergency dispersal a permanent decentralization program is being studied. The theory is that cities below a certain density are not good atomic bomb targets, hence, if a decentralization plan is initiated, no such attack may ever come. Characteristics such as mobility, autonomy, rapid construction, high volume production potential, and low cost are becoming the new measuring sticks of housing. It is necessary to avoid the so-called temporary dwellings simply because the length of their useful life is indefinite. Thousands of these buildings stand throughout the country, providing obsolete, poor housing. The industrialized house is far superior to these temporary quarters. Housing, because of the nature of the situation (mobility, decentralization), has become a national security resource, to be husbanded and carefully studied to raise the caliber of the product. It of course seems a pity that only the threat of war may succeed in forcing good housing upon us but the opportunity is here and we must make the most of it. The government may again appropriate funds to encourage the study of industrialized housing. The decentralization of essential industry with its housing needs may also force action. The prefabricated house offers the quickest way to supply shelter. The concept of the autonomous dwelling, completely free from community water, energy, and disposal systems, can become a reality. Many peacetime benefits can result from threats of war, but only through the cooperation of human and technical resources as at MIT with the other groups involved can the frustrations of the industrialized housing industry be eliminated. If the nation was made aware of the immediate and long range social needs, which can be solved only by the "home," the goal of better homes for more people at lower cost, through use of standard industrial procedure, would become a reality.



The hardest material made by man is which of these?

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In the Norton Research Laboratory, William C. Arthur, B. S. in A. E., Cornell '48, studies a problem in abrasive development.

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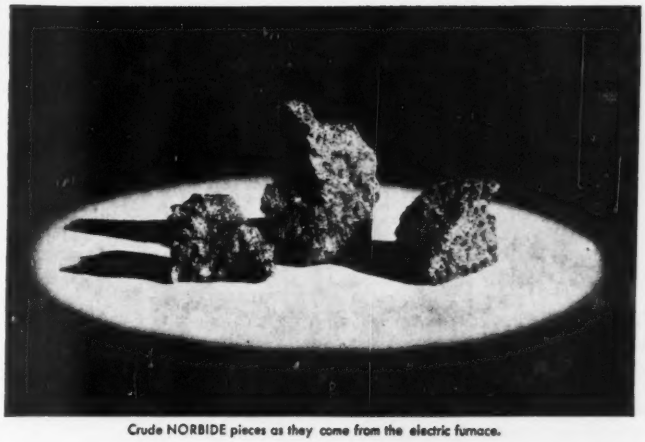

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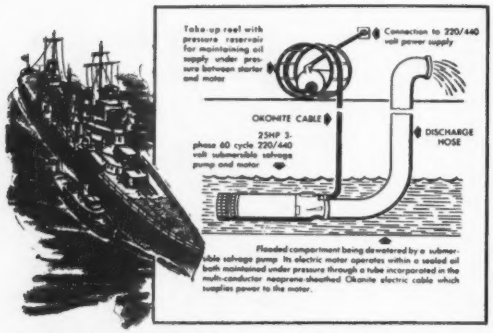
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This historic trip was made possible by the vessel's salvage pumps which were served by unusual "double-duty" Okonite cables. These specially made cables not only supplied power to the electric motors in the pumps, but also maintained a constant oil supply to the pumps through a tube *in the same cable.* Despite many weeks of submersion in oily sea water, the Okonite cables retained their original properties.

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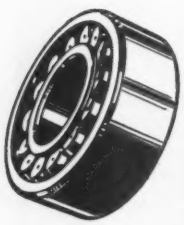

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BEARINGS

summer cycling through europe

(*Continued from page 30*)

our bitterest enemies, and saw places, once the goal of our armies. We were impressed by the fact that Germany was more like America than any other nation we visited.

The Low Countries, Holland and Belgium, are easy to cycle through, except occasionally for the wind, and offer several interesting experiences. Our stay in Belgium was unusual because the night we arrived the rioting over King Leopold's return broke out. That night we had a party down at the square where all the activity had been and on our way back to the hotel we passed through streets filled with armed police. The next afternoon just as we left the square a man was killed by the Gendarmes.

Paris, the Queen of Europe, is a must for all travelers. The ideal way to visit the city is to avoid the well known tourist spots. In fact this should be taken as a cardinal rule in all trips of this kind. The experiences that will mean the most to you later are those which you create yourself.

the case of the annoying microinch

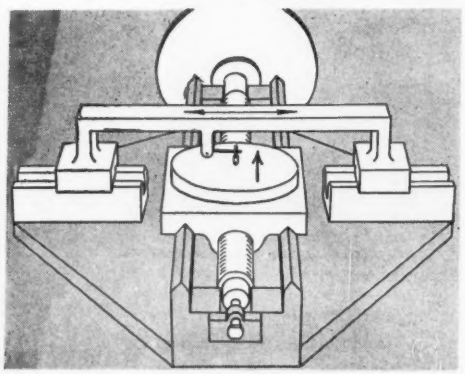
(*Continued from page 34*)

Rowland's simple design for a ruling engine is pictured. A screw turns to advance a carriage along ways to take up the position for successive lines. The grating blank, held on the carriage, has lines made on it by a diamond attached to a carriage moving perpendicular to the ways.

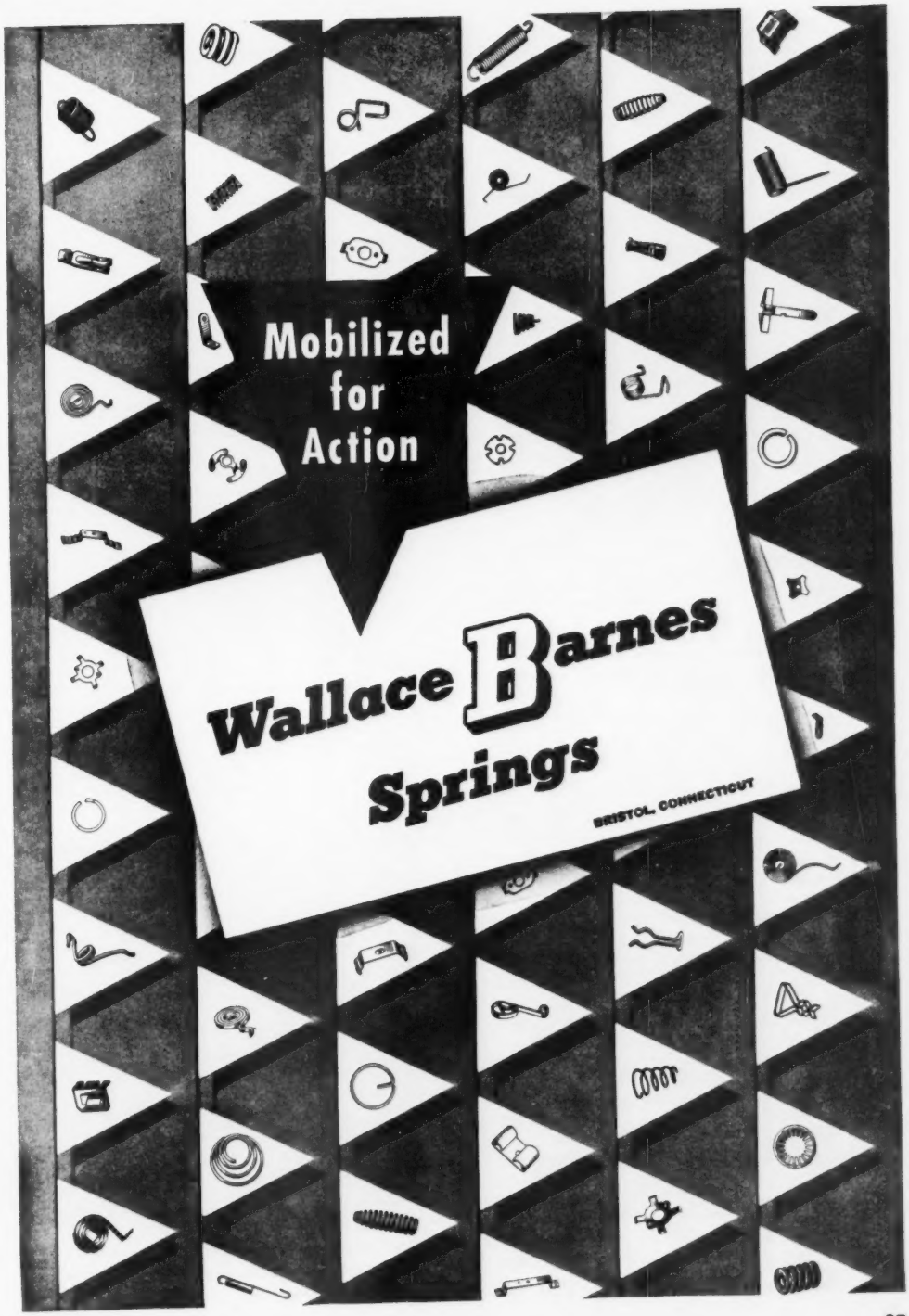
Simple enough, but the trick is to eliminate the errors proceeding from the bending of the frame, inaccuracies in the thread, longitudinal movement of the screw in its bearings, variations in sliding friction, sag of the screw and so on. Any one of the things would cause errors in excess of a millionth of an inch, which is the maximum allowable error from correct line position *over the whole length of the grating.*

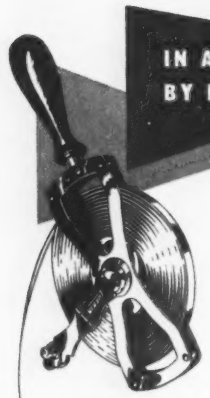
The problem is really tough. But it has not lacked vigorous attention, for just that reason. There was Rowland, who at the age of thirty-one took a challenge flung at him by an associate at Johns Hopkins, and proceeded to build in three years the engines which were to make the best gratings up to his time. The first of the serious engine builders, Rowland produced

(*Continued on page 38*)



The Rowland design for the ruling engine.


Mobilized
for
Action
Wallace Barnes
Springs
BRISTOL, CONNECTICUT



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from the earth's vaults

(*Continued from page 22*)

a souvenir of an American G.I. Many have searched for it, and it is thought that it is now somewhere in this country. If you should happen to have a recently acquired violin, take a good look at it. If it is inscribed:

EMELIE
Antonio Stradivarius
Cremona, 1732

then you are a rich man.

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Microscopes, Telescopes, Theodolites, Optical Squares, Engineers' Levels, Refractometers, Polarimeters, Industrial (Pulfrich) Photometers.

the case of the annoying microinch

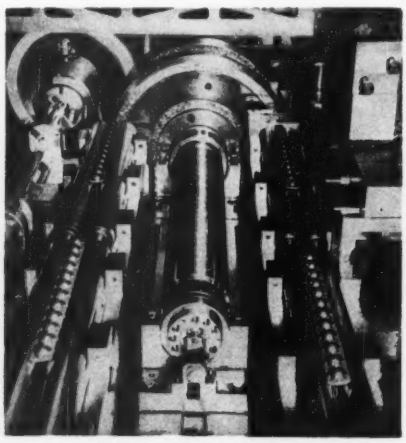
(*Continued from page 36*)

gratings which are rarely surpassed even today, and that was back in 1880. The three engines of his design survived the Baltimore fire of 1904 only to be ruined by an enthusiast who believed that the best contact between screw and carriage would be achieved by casting babbitt metal around the screw threads. Result: the screw buckled from the heat. But later these machines were restored by Anderson and Wood and now turn out the world's best gratings, with 400,000 resolving power.

Michelson, working at Chicago, was determined to make an engine for ruling gratings wider than the 7½" variety then available from Rowland's engines. He succeeded, but with the disastrous end results mentioned. But his followers at Chicago, notably Gale, spent a good deal of energy in improving the performance of Michelson's engines, and in partially completed form they were given to Bausch & Lomb and M. I. T. in 1947.

To meet the demand for wider gratings several groups are working cooperatively rather than competitively toward a solution. Dean of Science George R. Harrison at M. I. T., in rebuilding the Michelson engine given to us in 1947, hopes to beat Nature at her own game by correcting continuously and automatically for errors during the ruling process. Using the principle of feedback, Harrison has constructed a servomechanism device which constantly contrasts interferometrically the actual and correct position of the carriage as it is moved by the screw.

To be sure, the great engine rests in an oil bath inside a room temperature controlled to 0.01° C. Every precaution has been taken to eliminate the influences which cause inaccuracies. But the true hope of the M. I. T. group lies in the correcting properties of the "commensurator," as the servo is called. Preliminary results seem good. If they are successful, the M. I. T. group can rule 14" gratings, with the best attainable resolving power. Clever gadgetry and some good engineering may yet succeed where temperamental genius failed.



The 14" Michelson engine at M.I.T., showing the screw in the center and the ball-bearing ways on which the carriage moves.

THE DU PONT DIGEST

The Brains Behind the "Electric Brains"

How Du Pont Research engineers apply electronics to chemical manufacture

When you hear that a scientist works for a chemical company, it's natural to assume he is a chemist. Oddly enough, the Du Pont Company employs about as many engineers as chemists for normal technical work. Many are chemical engineers. But when it comes to basic research on instrumentation—a very important activity—both chemists and chemical engineers are in the minority.

This fundamental work is largely carried out in a laboratory of the Engineering Department, where electrical engineers, physicists and other scientists are deeply involved in electronics studies. They have some amazing devices to their credit—devices for monitoring industrial operations continuously and automatically.

Some of their ideas are spurred by a need in an existing plant. But the design of a new one may also lean heavily on novel instruments. Take, for instance, a new Du Pont plant that uses cyanides. Of course, these compounds are very poisonous. So when the plant was being designed, engineers were aware of the importance of detecting accidental contamination of the cooling water. In fact, the whole question of getting into production hinged on the problem of dealing with plant effluents.

J. Packard Laird, *B.S. in M.E., Princeton 1942, operates Dielectric Yarn Gage in order to determine small changes in the denier of synthetic textile yarns.*

Chemical-electronic watchdog

Once the only way to detect a fraction of a part per million of cyanide was to raise fish in water containing plant effluents. But this required a staff of experts to check constantly on the health of the fish. It was too slow and inaccurate. So the engineers developed a "chemical-electronic watchdog." Twenty-four hours a day, it automatically analyzes for cyanide to one part per million. If an excessive amount is present, it rings an alarm bell. Periodically, the machine pumps cyanide through itself to be sure it is registering. All the plant men have to do is take readings occasionally and fill the tanks with reagents once a week.

Fred R. Studer *(left), B. Met. E., Rensselaer Polytechnic Institute 1950, examines a Pressure Strain Recorder with Allen R. Furbeck, E.E., Princeton 1939.*

This is just one of many electronic devices developed by Du Pont research engineers. Others—ranging from ultraviolet gas analyzers and multivariable recorders to nylon denier gages—play a vital part in improving production methods. Many of them not only "observe" continuously, but automatically correct anything that goes wrong.

Research engineers at work

The term "research engineer," by the way, is a loose one. It may refer to an electronics engineer working on a new photo-multiplier circuit—or a physicist using his optics and spectrophotometry in designing a color-matching instrument. It may cover the activities of a physical chemist developing a continuous turbidimetric analysis—or a mechanical engineer evaluating a pneumatic servomechanism.

For the versatile young scientist, instrumentation research offers a fine opportunity to turn his talents into faster, better and safer production in the chemical industry.

DID YOU KNOW . . .

While Du Pont is the largest manufacturer of diversified chemicals in the U.S., its share of the total chemical business is only about seven per cent. It has one to fifteen major competitors for all its major product lines.

Richard G. Jackson *(left), B.S. in Ch. E., Columbia 1942, and Gregory L. Laserson, Ph.D. in M.E., Columbia 1949, test an Infrared Gas Analyzer which may be used to continuously analyze and control any infrared absorbing gas in a mixture.*

For the versatile young scientist, instrumentation research offers a fine opportunity to turn his talents into faster, better and safer production in the chemical industry.

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- Design of receiving, power, cathode ray, gas and photo tubes.

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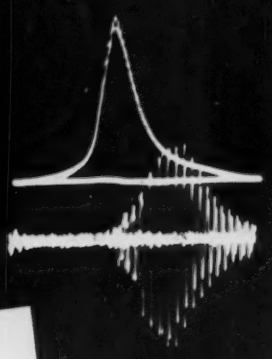
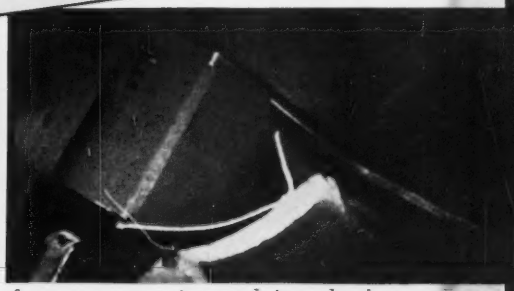


Engineering makes good use of photography's flashing speed

Reproduces Drawings In Seconds. Data, drawings, shop orders, specifications—all can be photocopied fast and accurately. Kodagraph papers, cloth, and film save time, protect originals from wear and tear—even produce legible copies from faded and worn material.

Captures The Flick of Instruments. The flash of the cathode-tube beam and the swift swing of the galvanometer mirror are not too fast for photography. It captures and records readings so that they can be analyzed and reveal all the information they contain.



Records Motion Far Too Fast To See. With the Kodak High Speed Camera a second of motion is spread over three minutes. You can analyze rapid movement, detect faulty action, spot points of wear, see ways to improve design and make a stronger, better product. (Illustration above shows part of a box carton sealing machine in action.)

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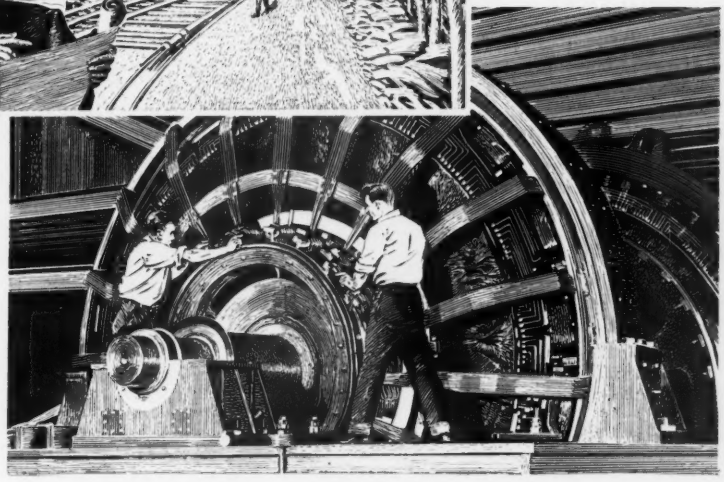
PROBLEM: INSTALL CABLE UNDER GREAT DIVIDE.

G-E engineers devised system for using irrigation tunnel to carry power cable. Al Lee, U. of Denver '37, directed project.



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For the Air Force, for example, General Electric builds jet engines, instruments, gunnery systems. For the Army: such products as radar and equipment for guided missiles. For the Navy: turbines to propel ships, electric drive and controls for turning turrets, etc.

For industry, General Electric builds the motors that drive steel mills, logging mills, printing presses . . . the electrical equipment for mines and textile mills . . . the turbine-generators that increase the nation's supply of electricity.

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